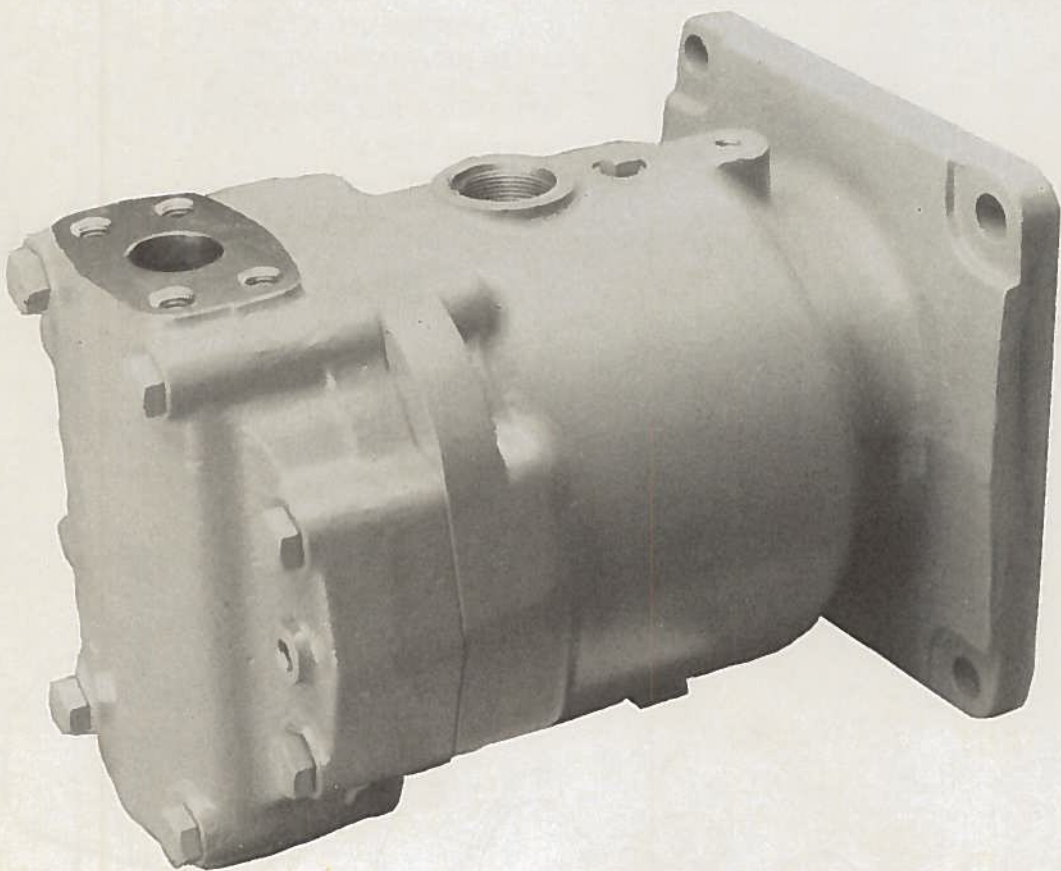




Service Parts Information

**Fixed
Displacement
Piston
Motors**

MFD80-*(E)-12

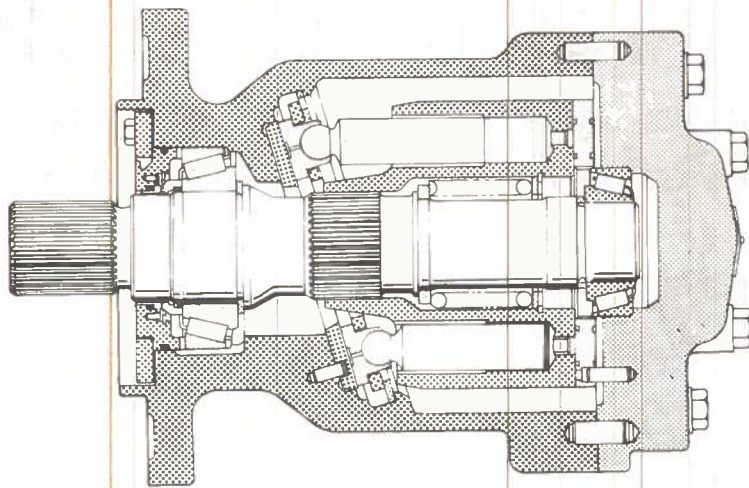


Vickers, Incorporated

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Troy, Michigan 48064

Revised 12-1-87

M-2753-S



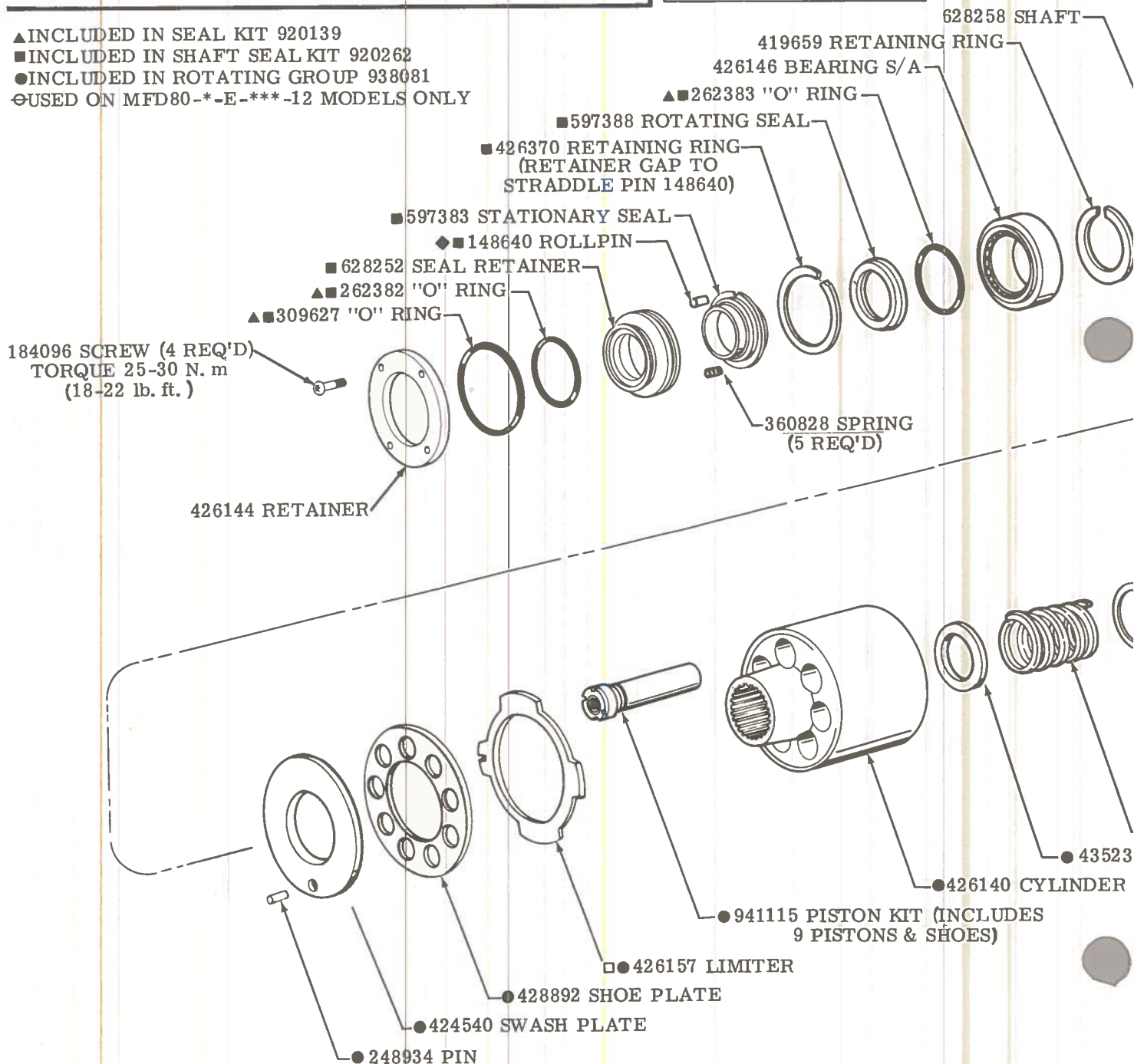
NOTE
PART NUMBERS PREFIXED WITH
A SYMBOL ARE AVAILABLE ONLY
IN SERVICE KITS.

◆NOTE
SLOT IN PIN TO BE RADIAL
TO SHAFT CENTERLINE ± 10

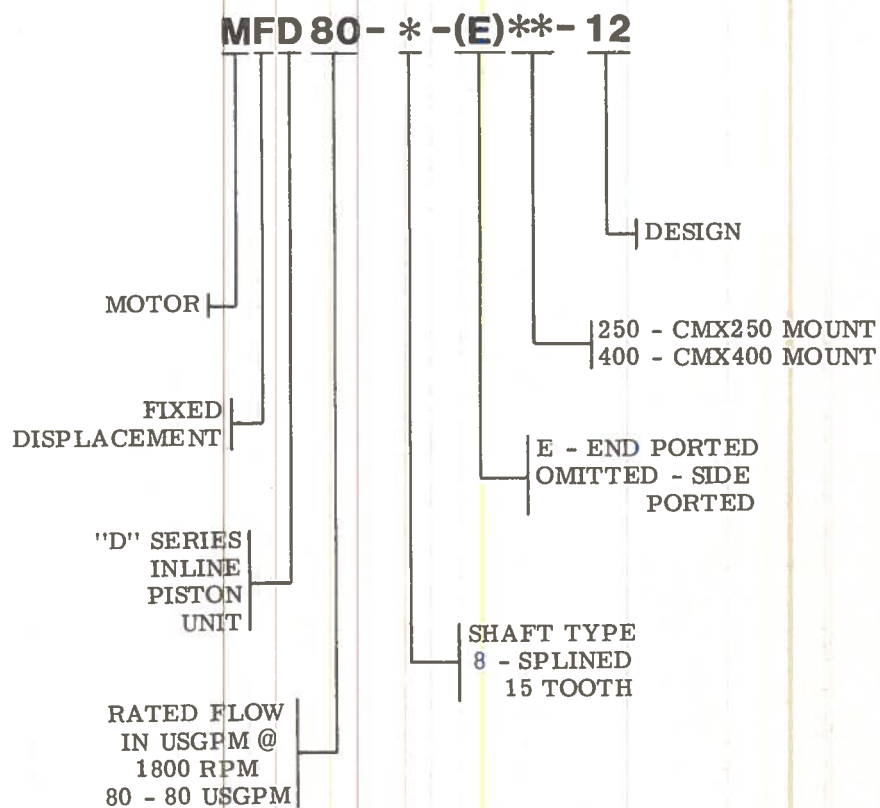
□NOTE
ASSEMBLE LIMITER WITH
CHAMFER TOWARD CYL-
INDER BLOCK.

NOTE
SHAFT RUNNOUT NOT TO
EXCEED 0.10 mm (0.004
INCH).

- ▲ INCLUDED IN SEAL KIT 920139
- INCLUDED IN SHAFT SEAL KIT 920262
- INCLUDED IN ROTATING GROUP 938081
- ⊖ USED ON MFD80-* -E-***-12 MODELS ONLY



MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

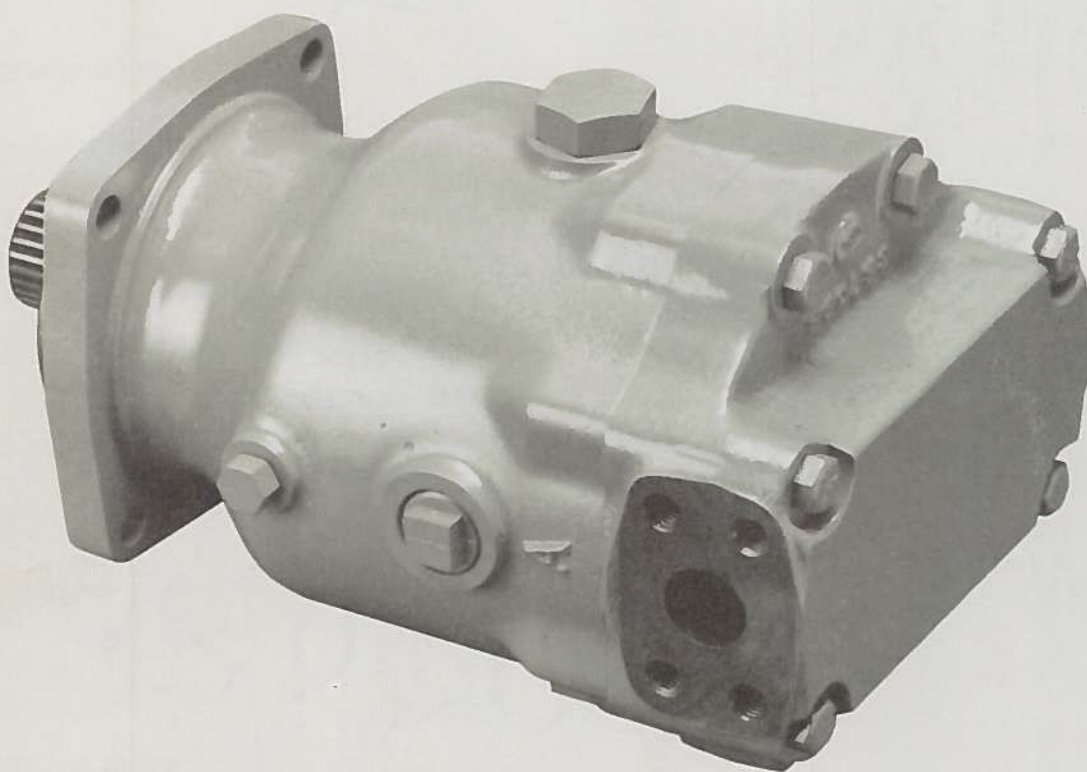
Litho in U. S. A.

VICKERS

Service Parts Information

FIXED DISPLACEMENT
PISTON MOTOR

MFD35-*-*21



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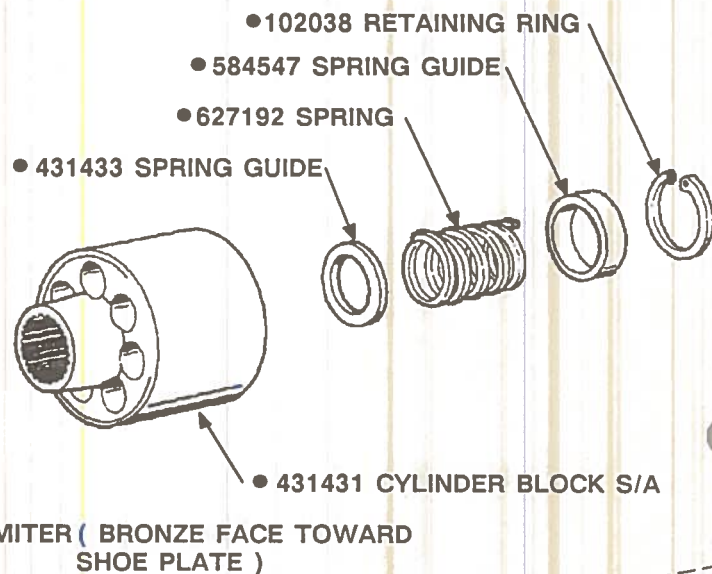
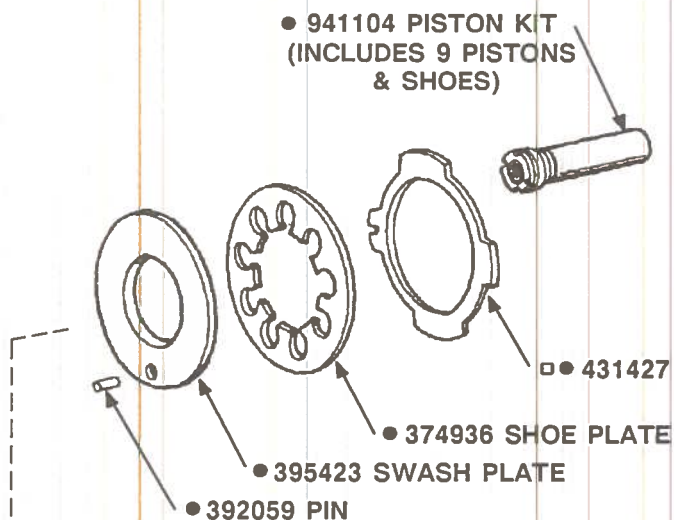
Released 6-1-88

M-2751-S

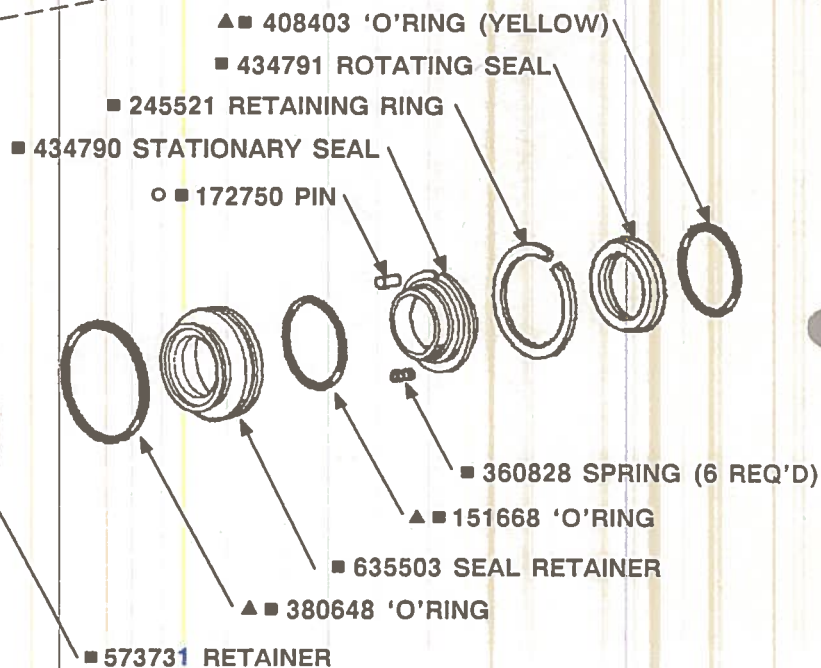
NOTE
PART NUMBERS PREFIXED WITH A
SYMBOL ARE AVAILABLE ONLY IN
SERVICE KITS.

CAUTION
DO NOT GREASE SEAL PARTS. FLOOD
WITH CLEAN SYSTEM FLUID. 'O' RINGS
MAY BE LUBRICATED WITH VISCOSITY
IMPROVER 'STP' OR EQUIVALENT.

NOTE
SHIM AS REQUIRED TO PROVIDE 0.00-0.10 mm
(0.000-0.004 INCH) SHAFT END PLAY. SHAFT
MUST BE ROTATED UNDER PRELOAD TO ALIGN
BEARING ROLLERS AT BOTH ENDS BEFORE
SETTING END PLAY.

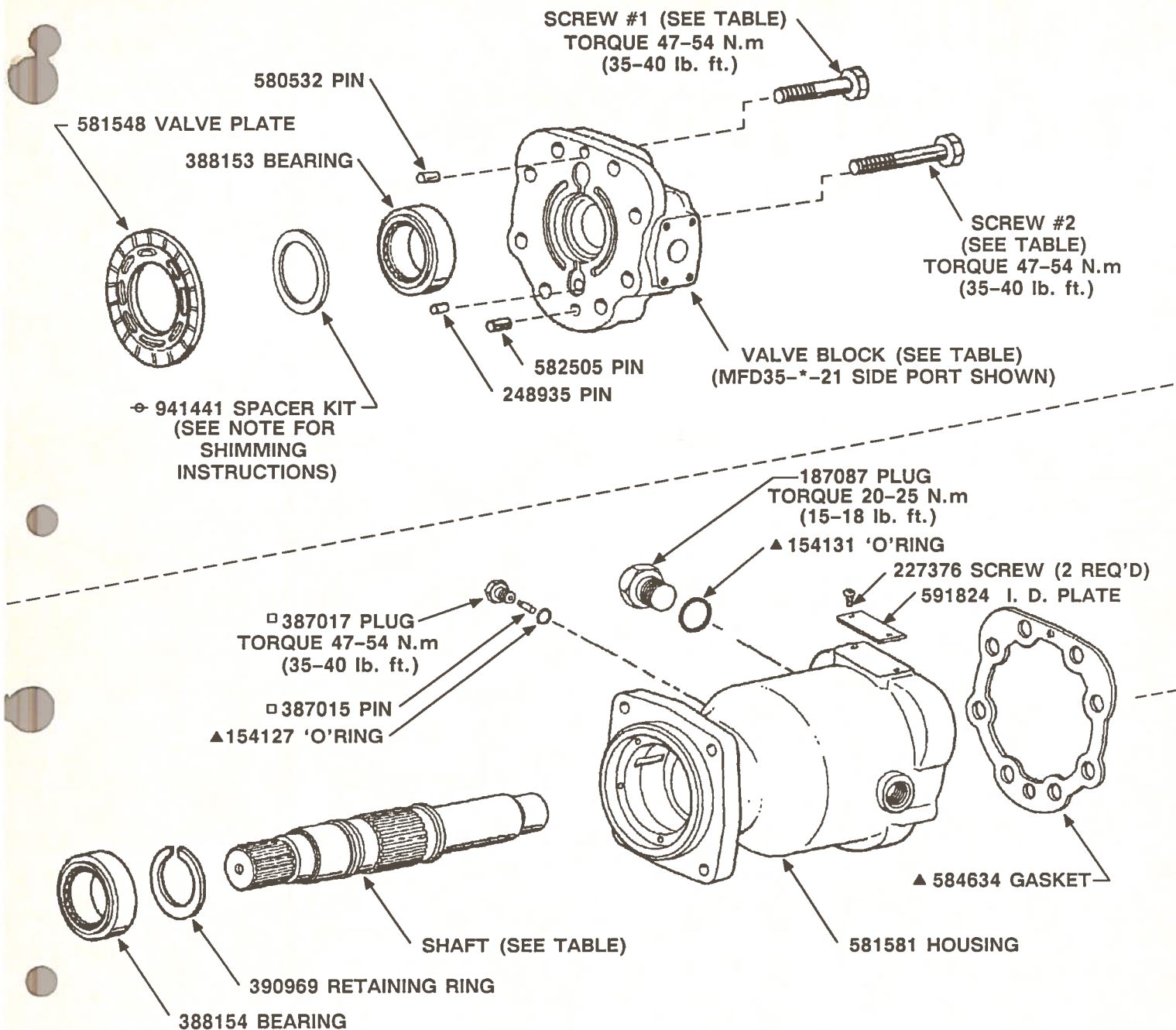


403279 SCREW (4 REQ'D)
TORQUE 7-8 N.m
(62-71 lb. in.)



SHAFT RUNOUT NOT
TO EXCEED 0.051mm
(0.002 INCH) T. I. R.

NOTE
SLOT IN PIN 172750 TO BE
RADIAL TO SHAFT + or - 10 °



MODEL	SHAFT
MFD35-1-21	635502
MFD35-7-21	675333
MFD35-10-21	675336
MFD35-12-21	675331

MODEL	VALVE BLOCK	SCREW #1	SCREW #2
MFD35-* -21	581549	214687 (4 REQ'D)	214683 (4 REQ'D)
MFD35-* -E-21	989187	298156 (8 REQ'D)	—
MFD35-* -E***-21	989178		

CAUTION
387015 PIN MUST ENGAGE 431427 LIMITER SLOT. IF 387017 PLUG WILL NOT SCREW ALL THE WAY DOWN PIN IS NOT PROPERLY ENGAGED. THE ROTATING GROUP WILL BIND UP AND POSSIBLE DISTRUCTION OF MOTOR WILL OCCUR AT START-UP.

- ▲ - INCLUDED IN SEAL KIT 920135
- - INCLUDED IN SHAFT SEAL KIT 920367
- - INCLUDED IN ROTATING GROUP 941105

MODEL CODE BREAKDOWN

MFD 35 - * - * - 21

1 2 3 4 5

1 MOTOR, FIXED DISPLACEMENT, D SERIES

2 SIZE - FLOW RATING (USGPM) @ 1800 RPM

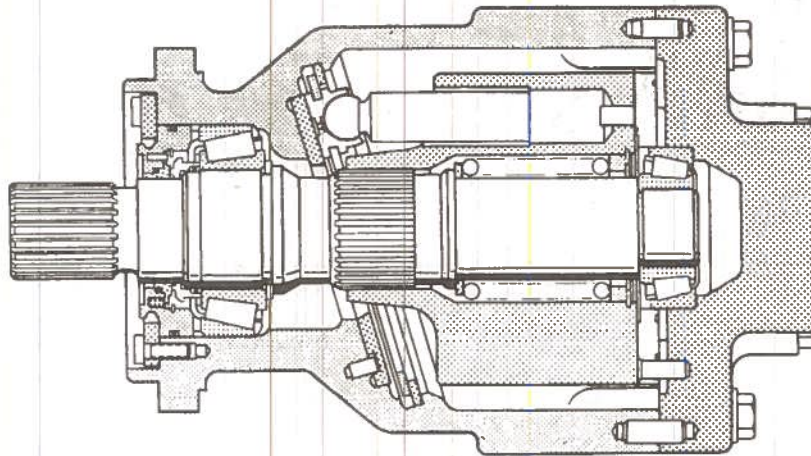
3 OUTPUT SHAFT

1 - SPLINED 14 TOOTH
7 - SPLINED 23 TOOTH
10 - SPLINED 17 TOOTH
12 - SPLINED 16 TOOTH

4 PORT OPTIONS

BLANK - SIDE PORT
E - END PORT
E*** - END PORT FOR CMX160, 250,
400 OR 630 VALVE MOUNT

5 DESIGN



MFD35-*-*-21 SECTIONAL VIEW

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 19/15 or cleaner. Selections from OFP, OFR and OFRS filter series are recommended.

Litho in U.S.A.

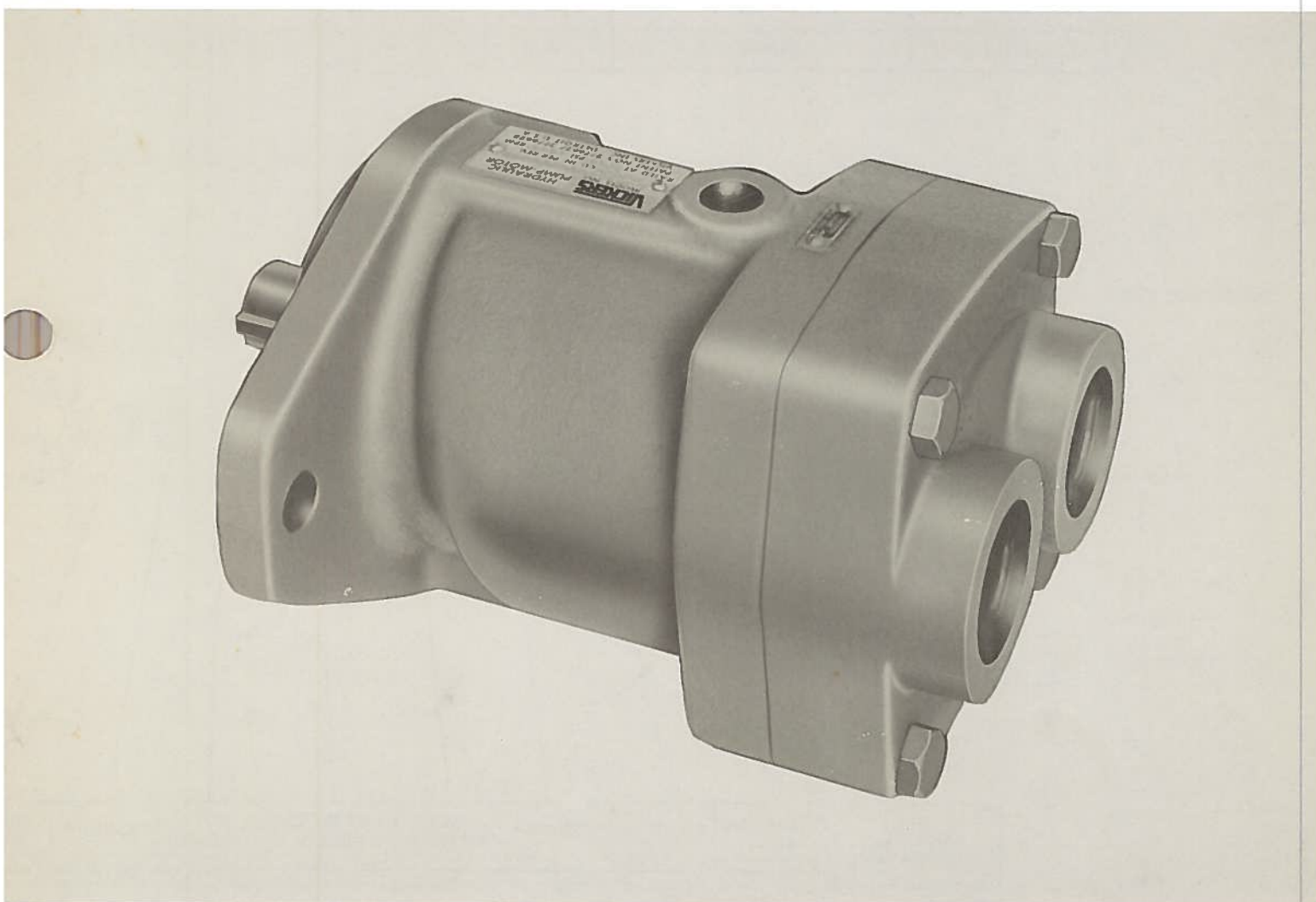


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Service Parts Information

**Fixed In-Line
Piston Motors**

M-MFB20 and M-MFB29-10 Design



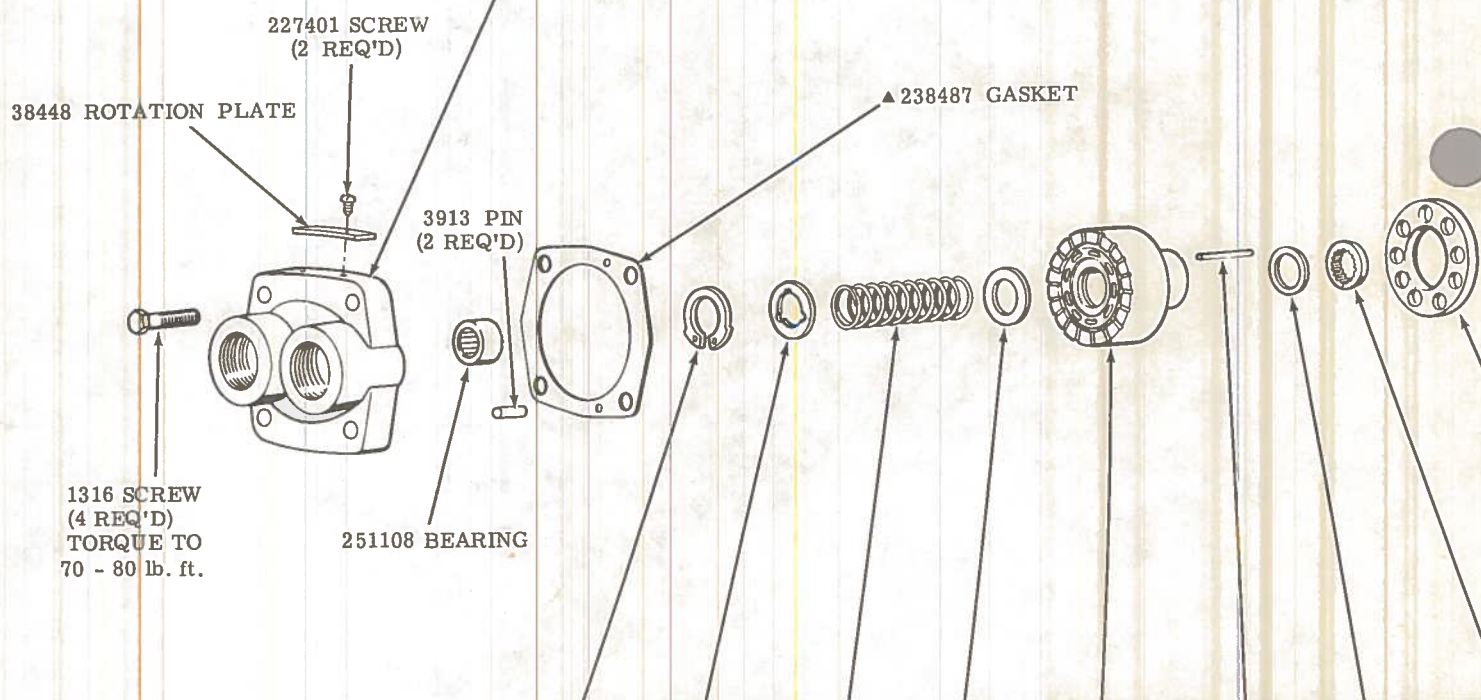
Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 9-1-85

M-2763-S

MODEL DESIGNATION	VALVE PLATE SUB-ASSY (INCLUDES ROTATION PLATE & 251108 BEARING)	SHAFT BEARING
M-MFB20-U-10	938383	283090
M-MFB29-U-10	941470	238482

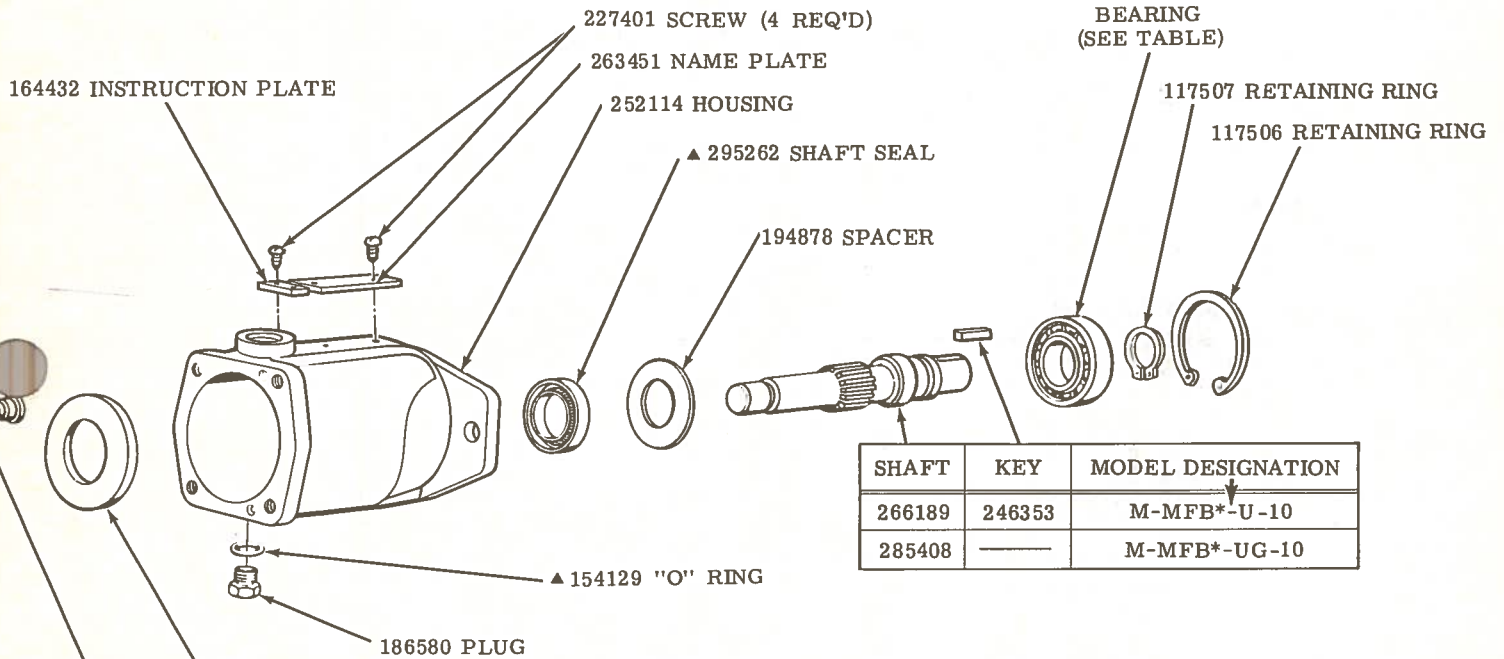
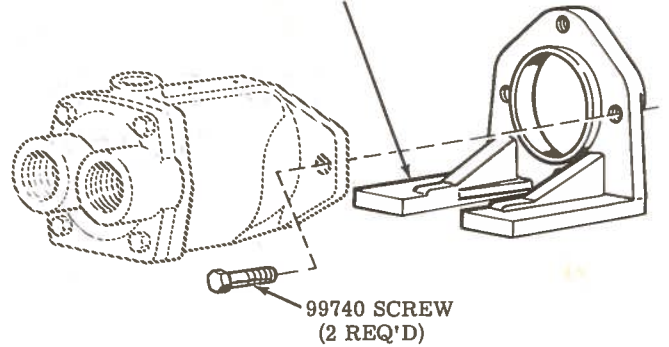


MODEL DESIGNATION	RETAINING RING	WASHER	SPRING	THRUST WASHER	CYLINDER BLOCK	PIN (3 REQ'D)	WASHER	SHAFT BEARING
THESE PARTS SERVICED IN ROTATING GROUP								
M-MFB20-U-10	194025	244931	246387	238780	284197	248835		938392
M-MFB29-U-10					287454			

INCLUDE COMPLETE MODEL NUMBER ON ALL PARTS ORDERS

FOOT MOUNTING BRACKET

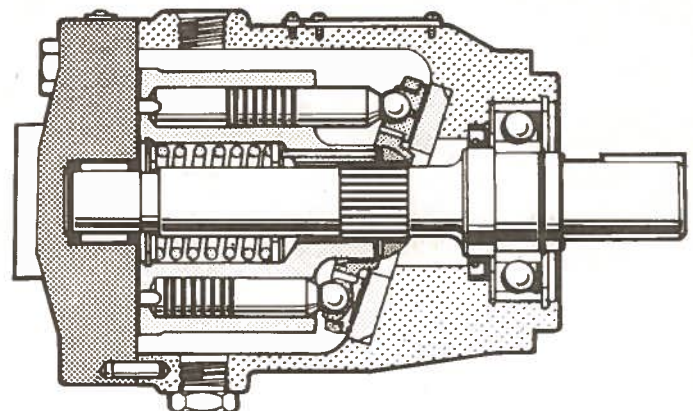
FB-B-10 MOUNTING KIT
(INCLUDES SCREWS)



SHAFT	KEY	MODEL DESIGNATION
266189	246353	M-MFB*-U-10
285408	—	M-MFB*-UG-10

SHOE PLATE	PISTON KIT (9 PISTONS)	SWASH PLATE	ROTATING GROUP KIT
248609	941884	239335	938281
	923326		922999

▲ SERVICED IN 919242 SEAL KIT



ASSEMBLY VIEW

SEE SERVICE MANUAL M-2760-S FOR MAINTENANCE INFORMATION

MODEL CODE BREAKDOWN

M - MFB - U* - 10 - *****

MOBILE

MOTOR

FIXED DISPLACEMENT

PISTON TYPE INLINE

USGPM RATING @ 1800 RPM

20 - 20 USGPM

29 - 29 USGPM

SPECIAL FEATURES

DESIGN NUMBER

SHAFT TYPE

G - SPLINED

OMITTED - KEYED

ROTATION

U - EITHER DIRECTION

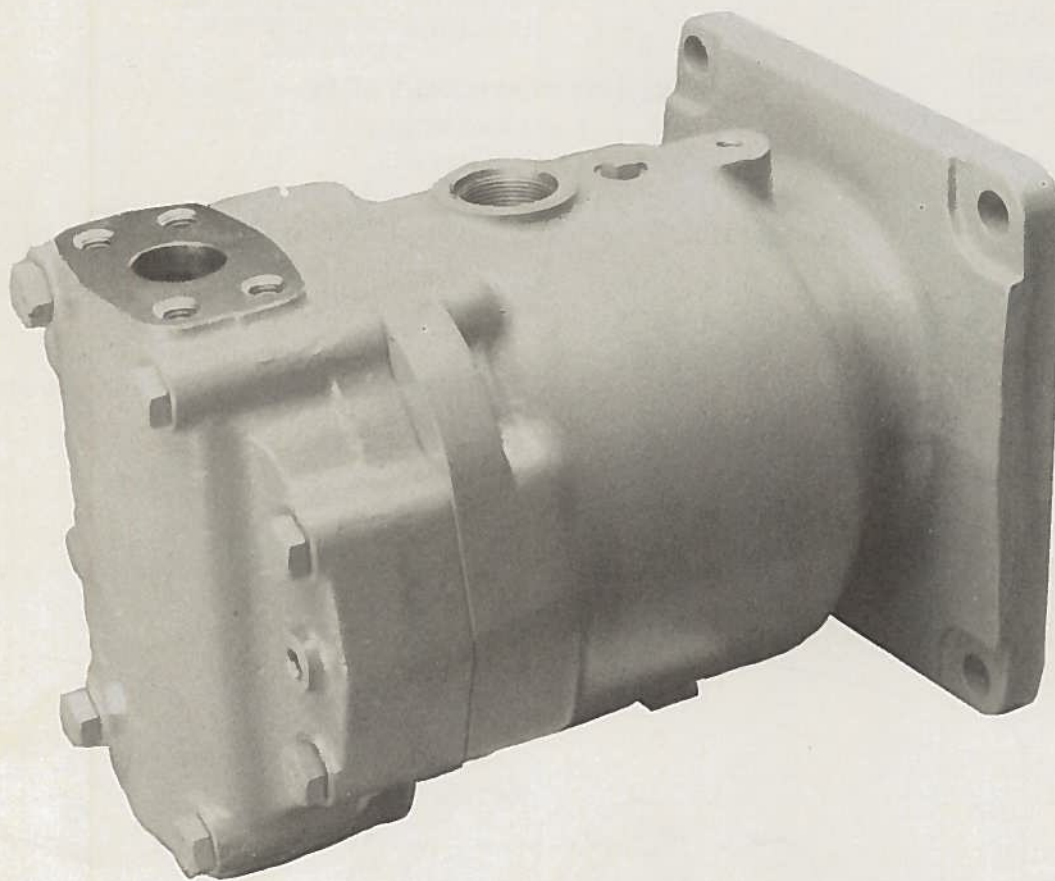
For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

LITHO IN USA

Service Parts Information

**Fixed
Displacement
Piston
Motors**

MFD120-*-12

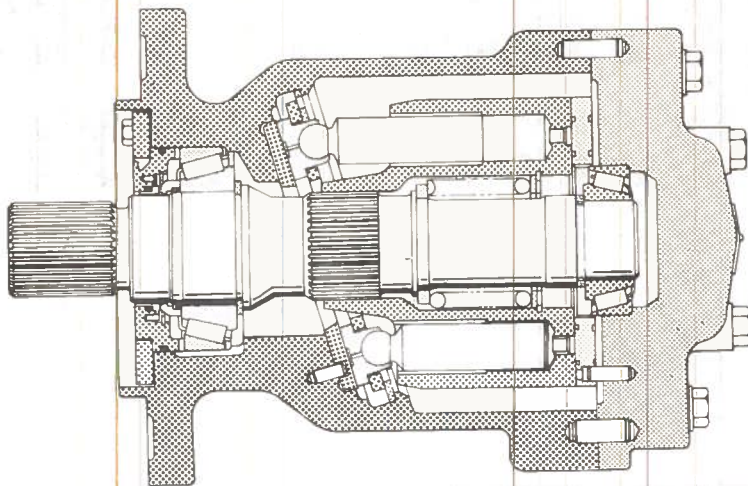


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Revised 12-1-87

M-2755-S



NOTE
PART NUMBERS PREFIXED WITH
A SYMBOL ARE AVAILABLE ONLY
IN SERVICE KITS.

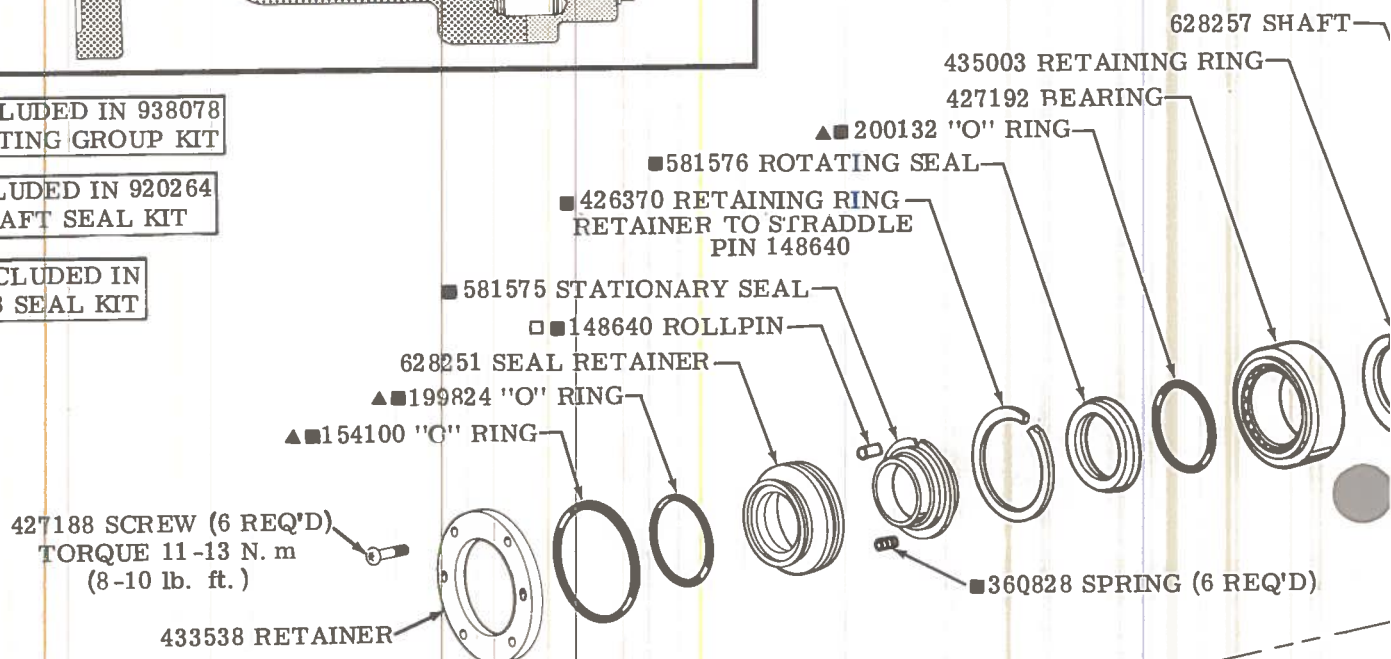
NOTE
SLOT IN PIN TO BE RADIAL
TO SHAFT CENTERLINE ± 10
DEGREES.

NOTE
SHAFT RUNOUT NOT TO
EXCEED 0.10 mm (0.004
INCH).

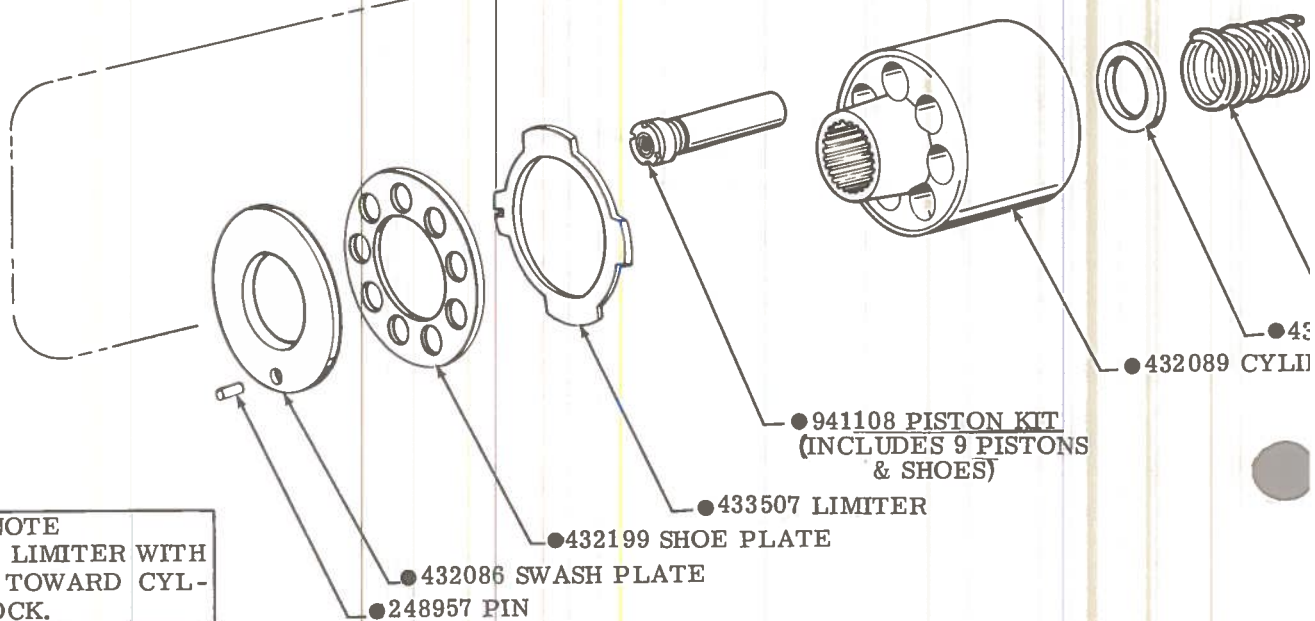
● INCLUDED IN 938078
ROTATING GROUP KIT

■ INCLUDED IN 920264
SHAFT SEAL KIT

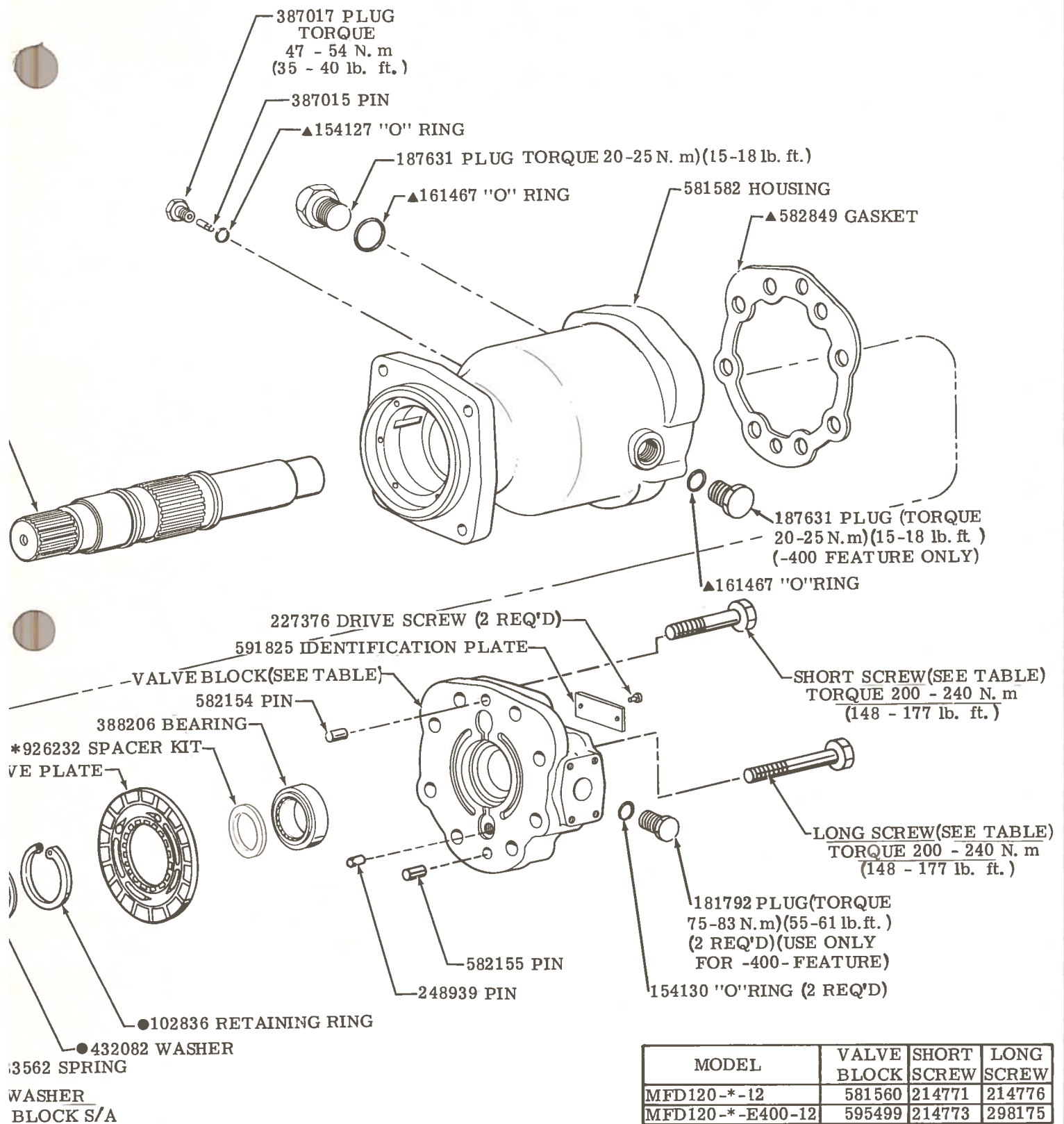
▲ INCLUDED IN
920133 SEAL KIT



587911



NOTE
ASSEMBLE LIMITER WITH
CHAMFER TOWARD CYL-
INDER BLOCK.



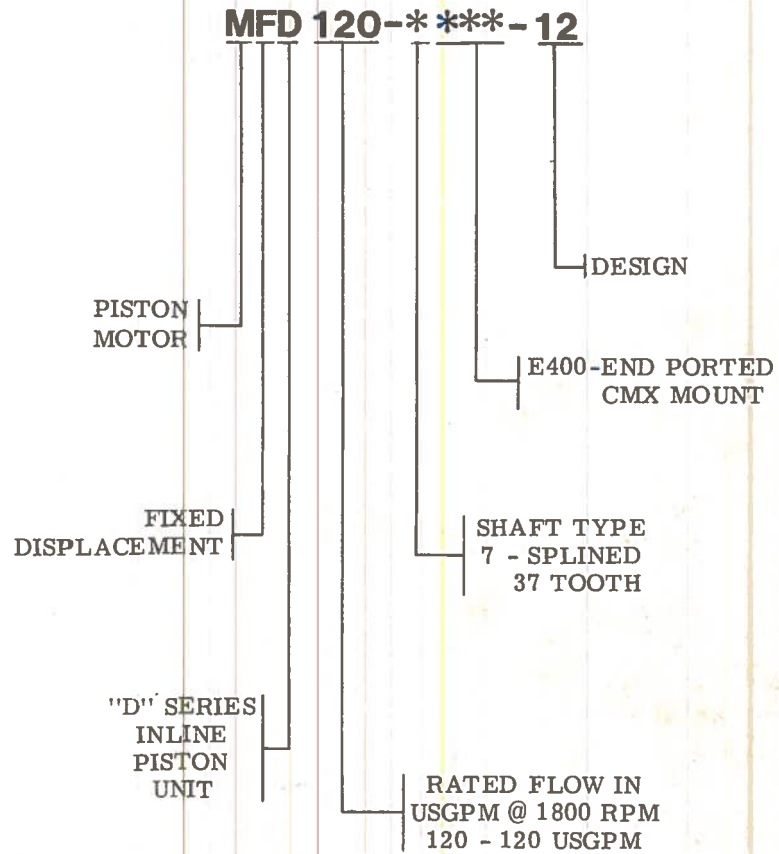
CAUTION

DO NOT GREASE SEAL PARTS. FLOOD WITH CLEAN SYSTEM FLUID. "O" RINGS MAY BE LUBRICATED WITH VISCOSITY IMPROVER "STP" OR EQUIVALENT.

*NOTE

SHIM AS REQUIRED TO PROVIDE 0.000-0.100 mm (0.000-0.004 INCH) SHAFT END PLAY. SHAFT MUST BE ROTATED UNDER PRELOAD OF 1100-1330 N. (247-299 lb. force) TO ALIGN BEARING ROLLERS BEFORE FINAL SETTING OF END PLAY. SEE OVERHAUL MANUAL M-2770-S.

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/13 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

Litho in U. S. A.

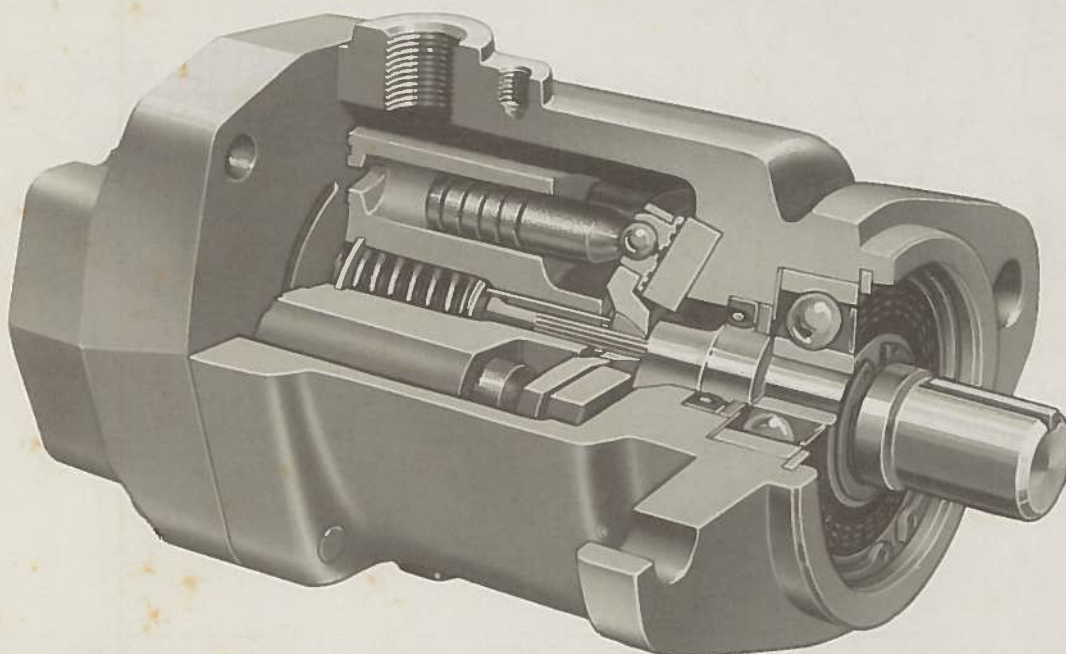
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Service Parts Information

**Fixed Inline
Piston Motor**

(M)-MFB45-U*-10



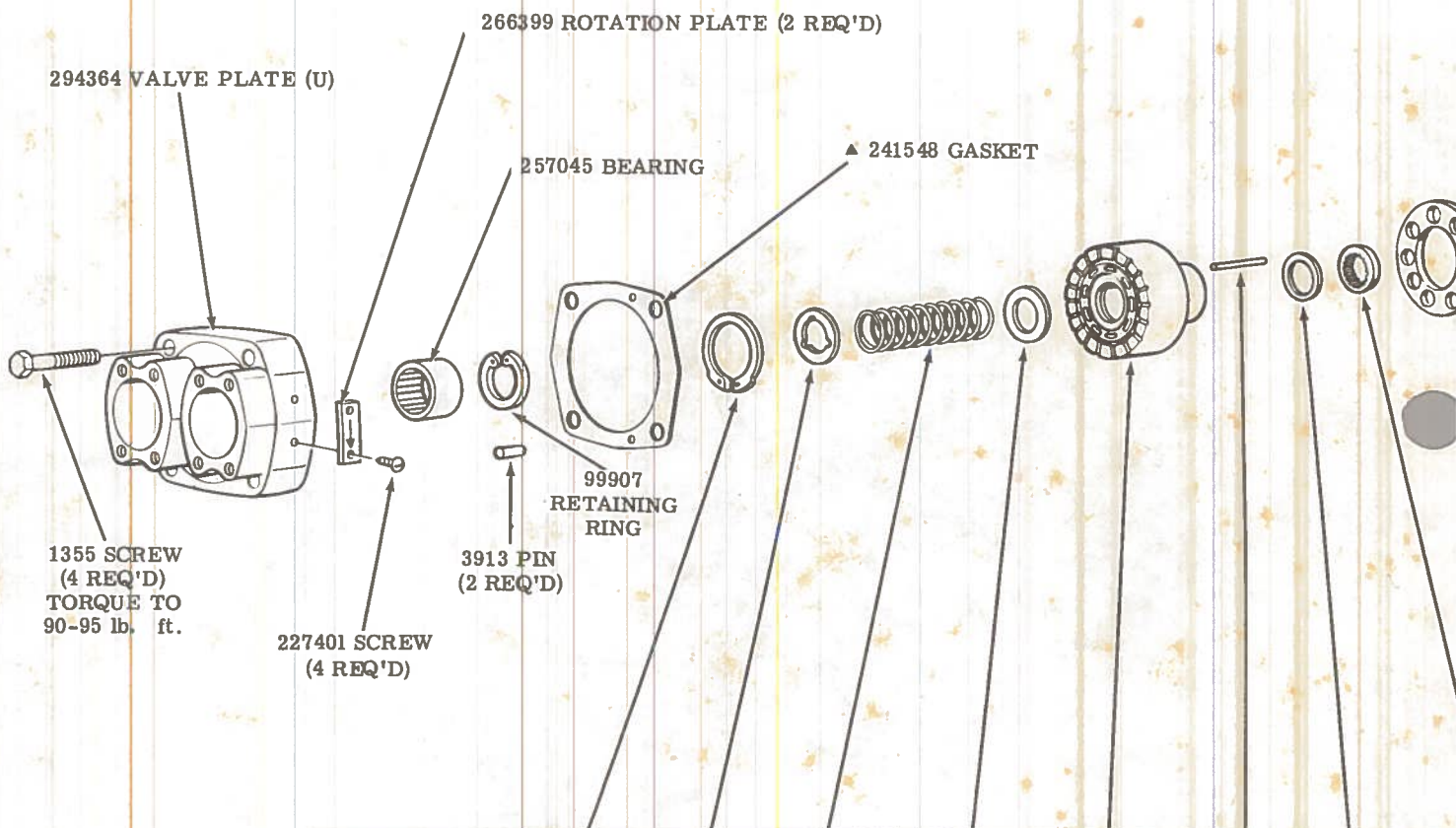
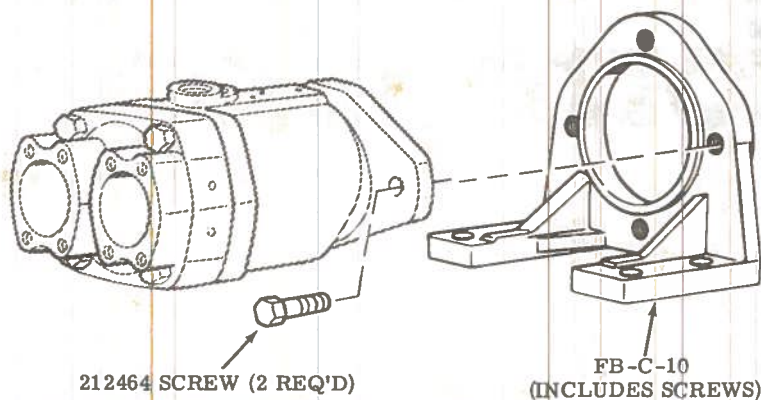
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Troy, Michigan 48007-0302

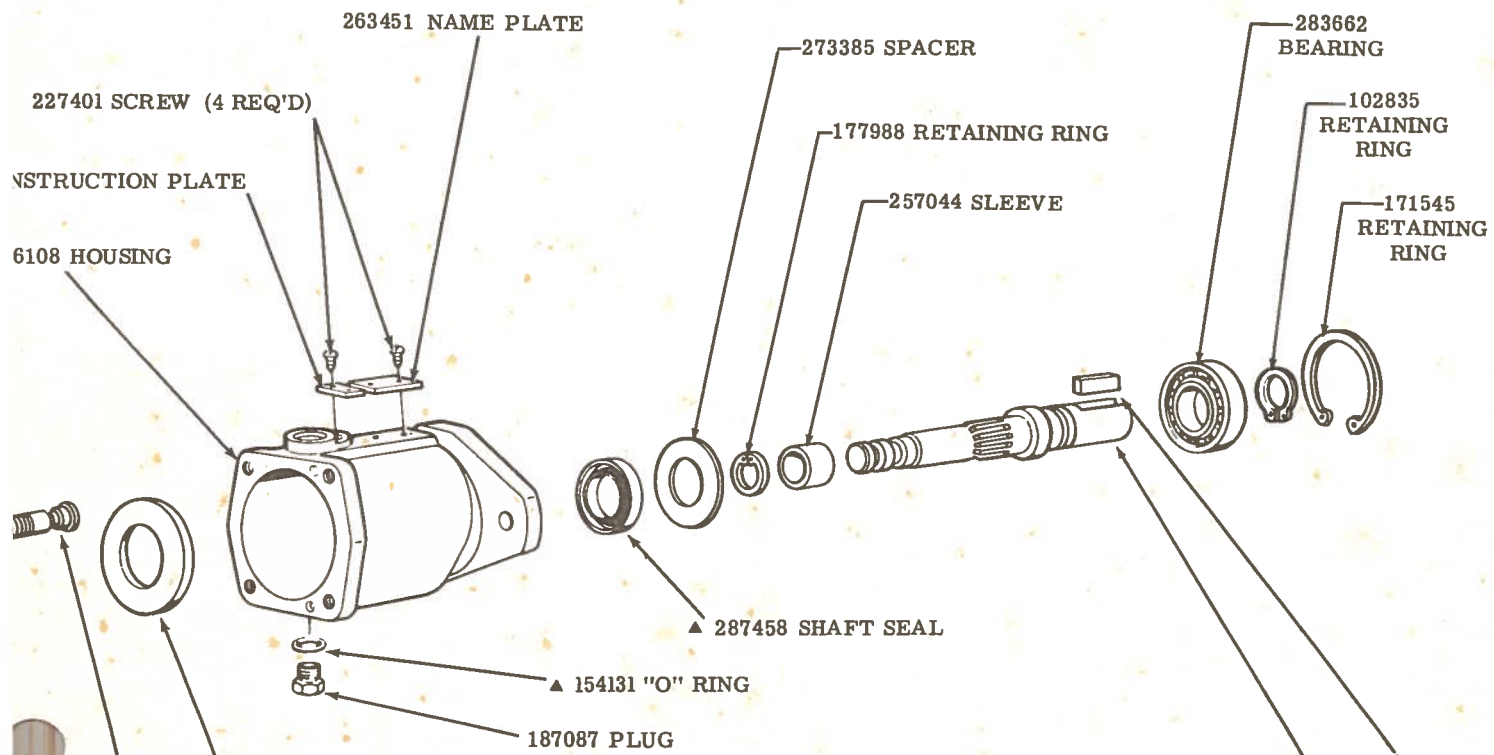
Revised 9-1-86

M-2764-S

FOOT MOUNTING BRACKET



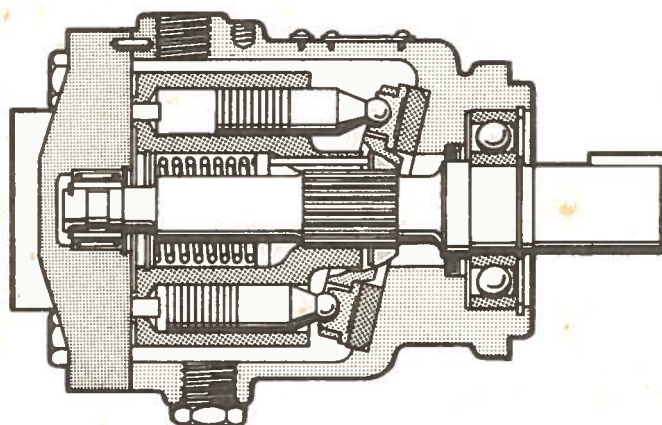
MODEL DESIGNATION	RETAINING RING	LIFT LIMITER	SPRING	WASHER	CYLINDER BLOCK	PIN (5 REQ'D)	WASHER	SPH WA
	THESE PARTS SERVICED IN ROTATING C							
M-MFB45-**-10	126911	246017	282557	253665	500594	248883	253664	2



MODEL DESIGNATION	SHAFT	KEY
M-MFB45-*F-10	294360	247101
M-MFB45-*E-10	322355	—

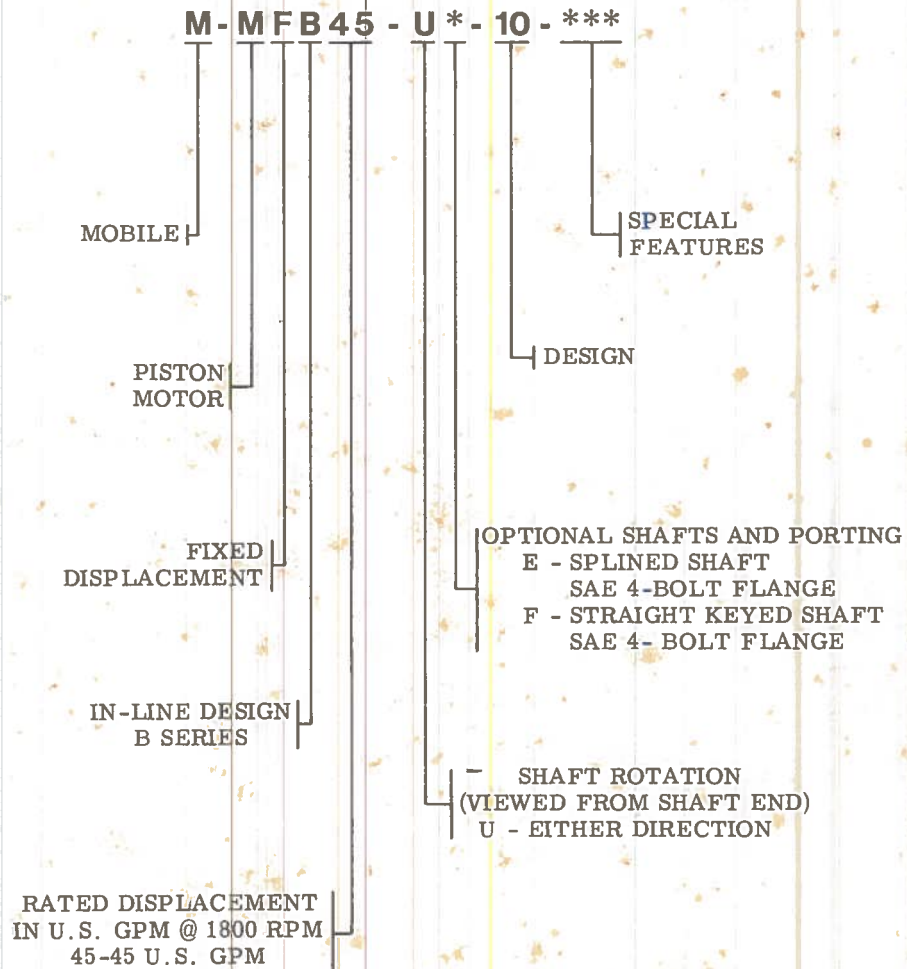
SHOE PLATE	PISTON KIT (9 PISTONS)	SWASH PLATE	ROTATING GROUP KIT
266112	923189	241543	923001

▲ = SERVICED IN SEAL KIT 923000



ASSEMBLY VIEW

MODEL CODE BREAKDOWN



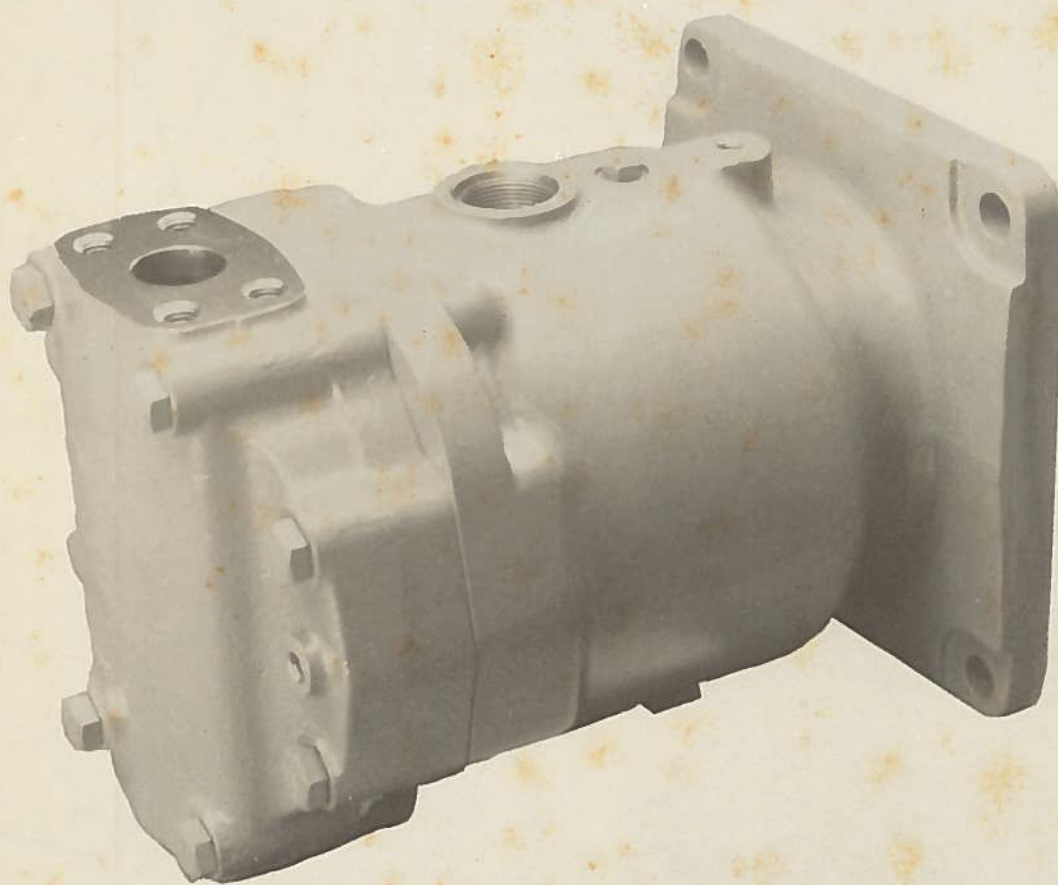
For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.



Service Parts Information

**Fixed
Displacement
Piston
Motors**

MFD45--20**



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Revised 1-1-88

M-2767-S

NOTE

* SHIM AS REQUIRED TO PROVIDE 0.030-0.10 mm (0.001-0.004 INCH) SHAFT END PLAY. SHAFT MUST BE ROTATED UNDER PRELOAD TO ALIGN BEARING ROLLERS AT BOTH ENDS BEFORE SETTING END PLAY.

NOTE

PART NUMBERS PREFIXED WITH A SYMBOL ARE AVAILABLE ONLY IN SERVICE KITS.

NOTE

SHAFT RUNOUT NOT TO EXCEED 0.15 mm (0.006 INCH).

MODEL	SHAFT
MFD45-6-20	581572
MFD45-10-20	584844

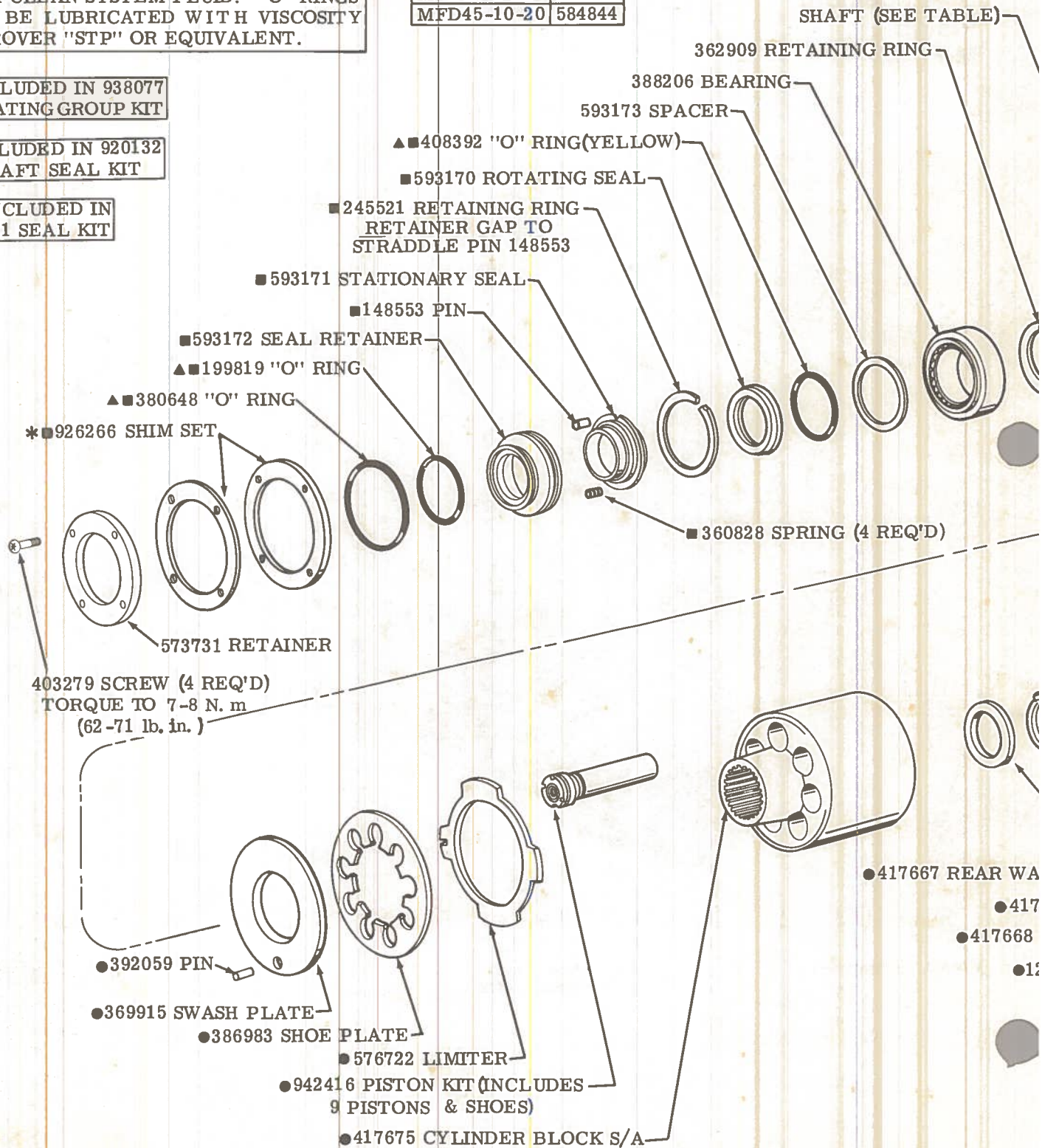
CAUTION

DO NOT GREASE SEAL PARTS. FLOOD WITH CLEAN SYSTEM FLUID. "O" RINGS MAY BE LUBRICATED WITH VISCOSITY IMPROVER "STP" OR EQUIVALENT.

● INCLUDED IN 938077 ROTATING GROUP KIT

■ INCLUDED IN 920132 SHAFT SEAL KIT

▲ INCLUDED IN 920131 SEAL KIT



387017 PLUG TORQUE TO
47-54 N. m (35-40 lb. ft.)

387015 PIN

▲154127 "O" RING

187087 PLUG TORQUE TO
20-25 N. m (15-18 lb. ft.)

▲154131 "O" RING

227376 DRIVE SCREW (2 REQ'D)

591825 IDENTIFICATION PLATE

581585 HOUSING

▲584845 GASKET

214687 SCREW (4 REQ'D)
TORQUE TO 47-54 N. m
(35-40 lb. ft.)

580532 PIN

214683 SCREW (4 REQ'D)
TORQUE TO 47-54 N. m
(35-40 lb. ft.)

581564 VALVE BLOCK

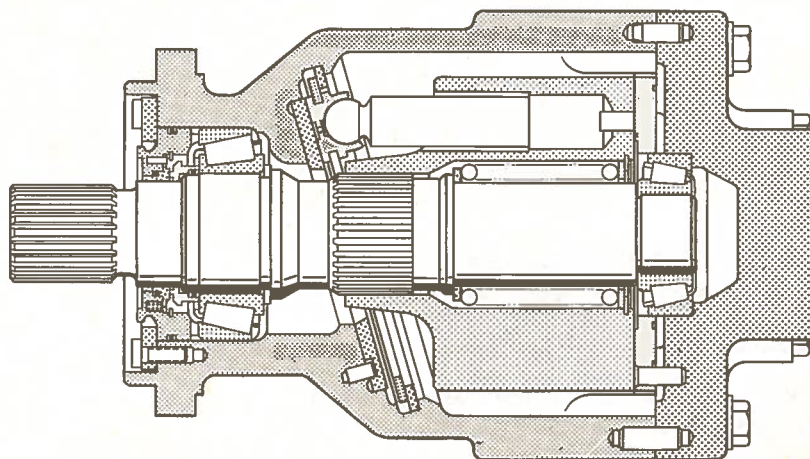
582505 PIN

248935 PIN

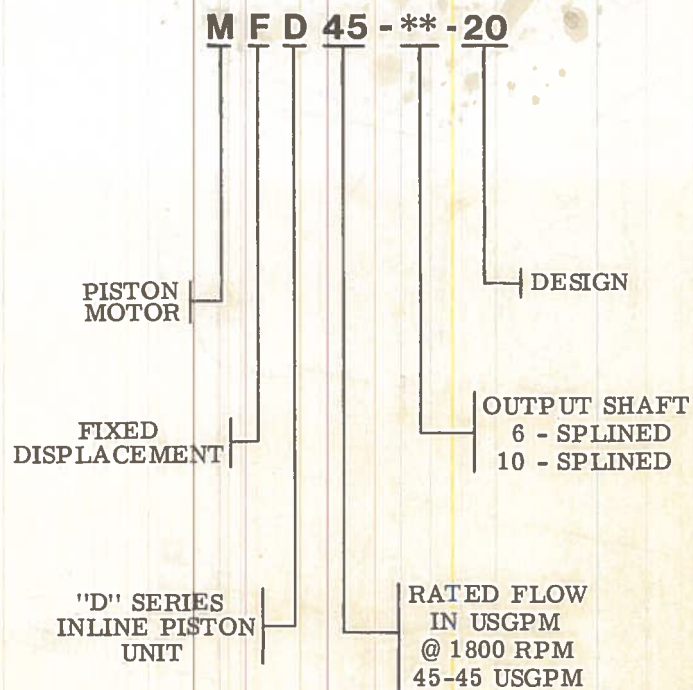
SPRING
WASHER
RETAINING RING

581563 VALVE PLATE

576600 BEARING



MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

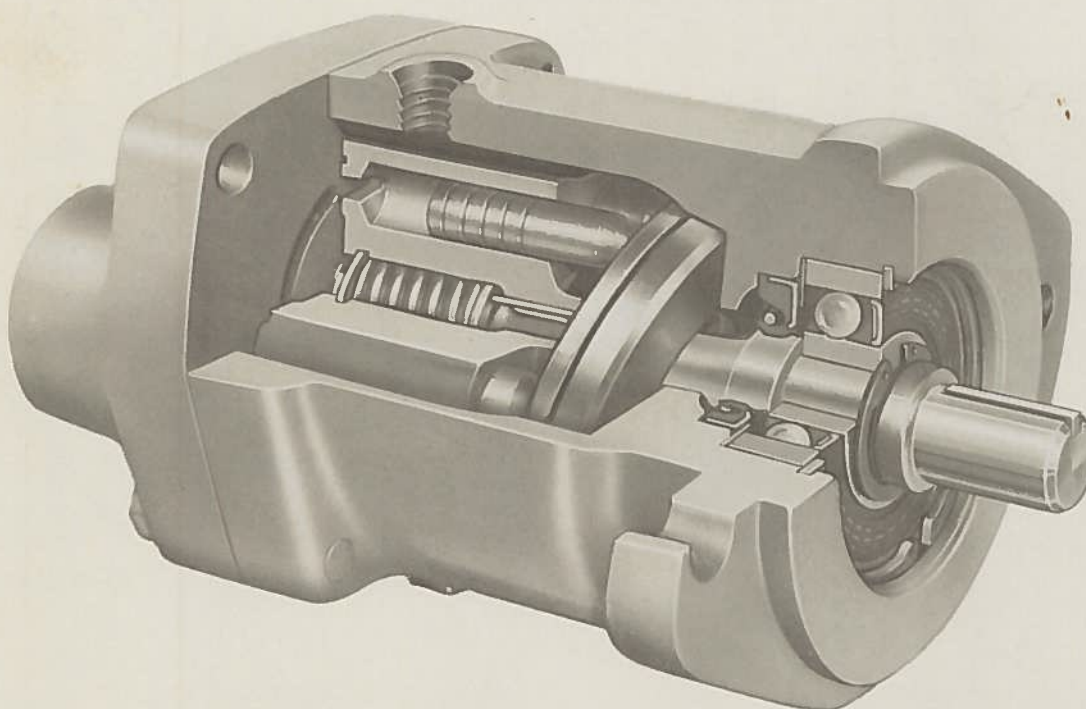
Litho in U. S. A.



Service Parts Information

Fixed
Inline
Piston
Motors

M-MFB15-31



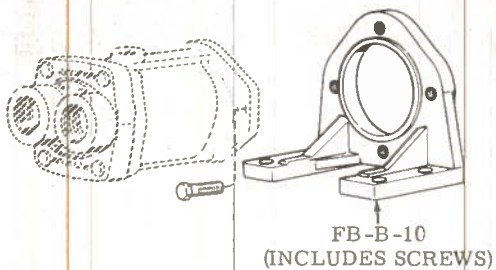
Vickers, Incorporated

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Troy, Michigan 48084

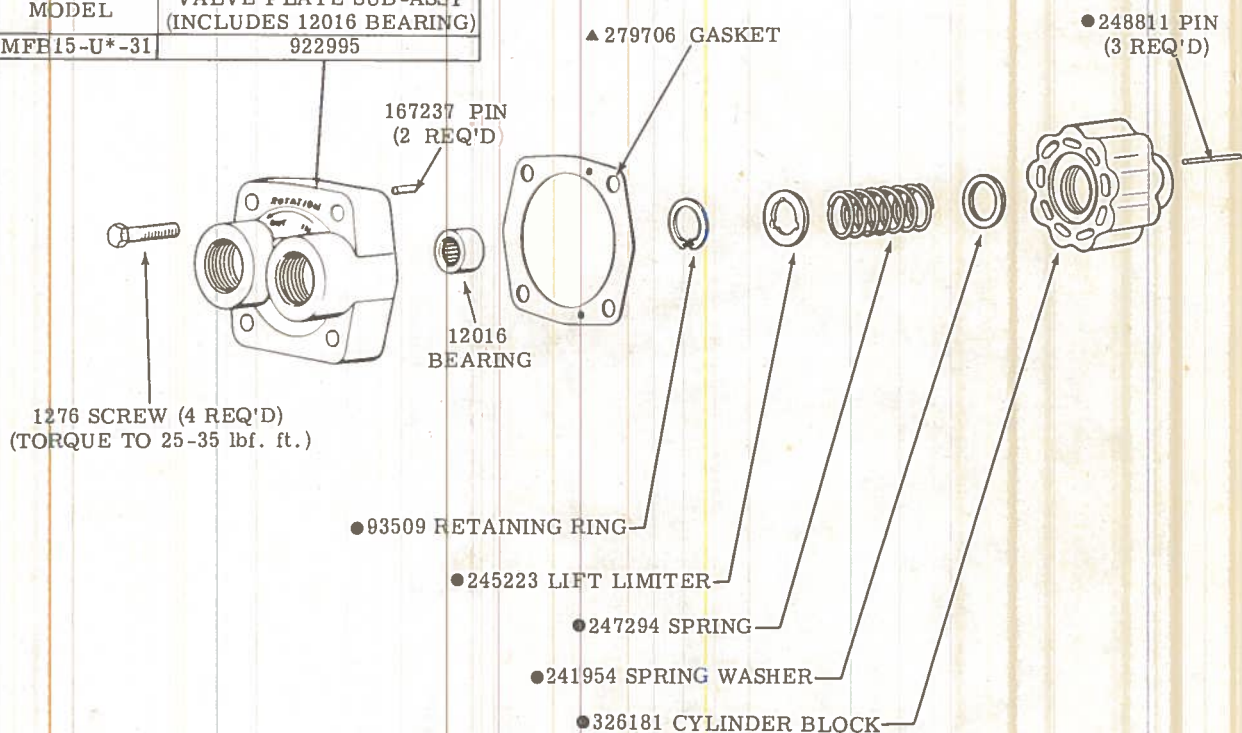
Revised 11-1-85

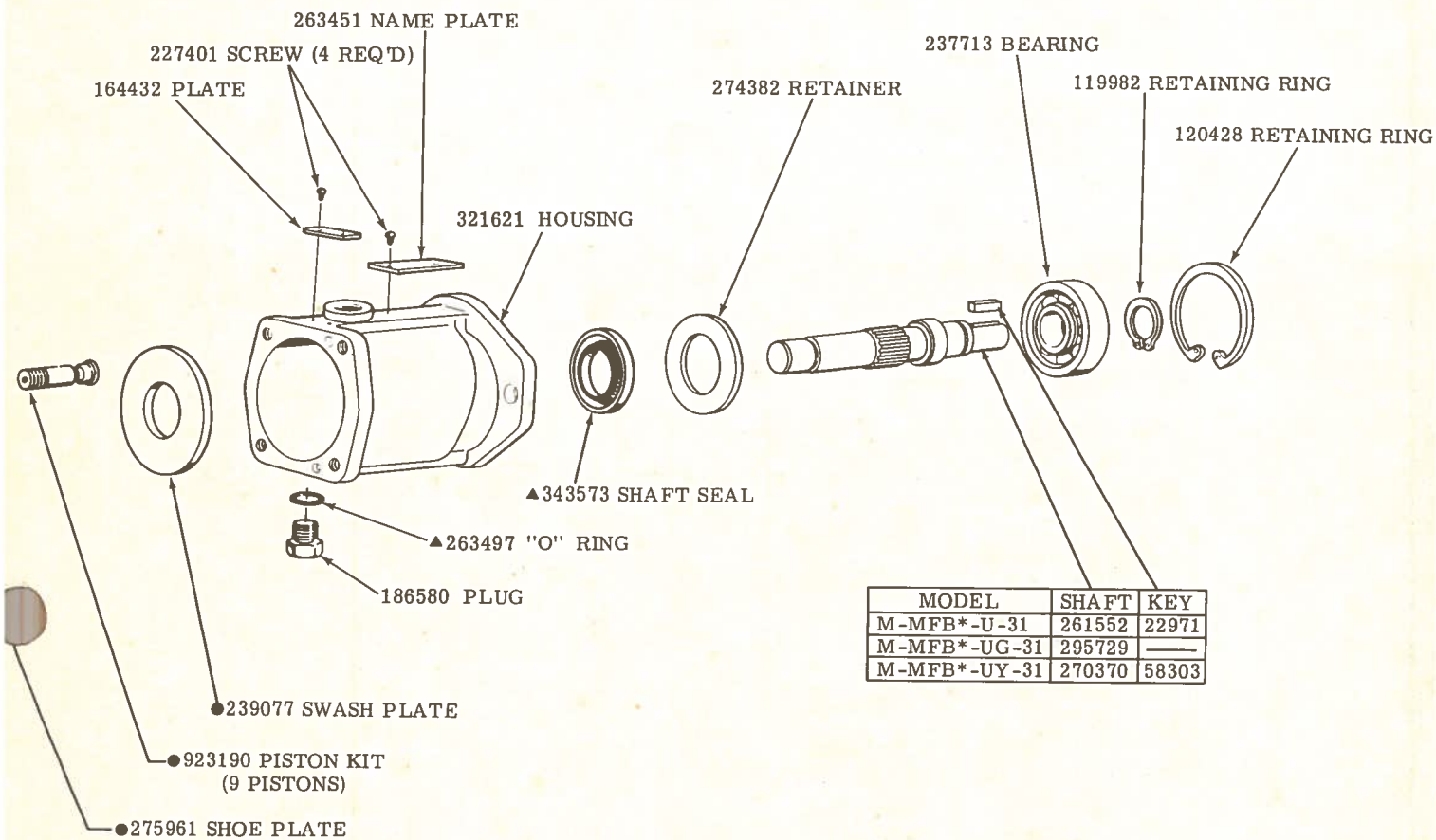
M-2765-S

FOOT MOUNTING BRACKET
MODEL M-MFB*-F-31**



MODEL	VALVE PLATE SUB-ASSY (INCLUDES 12016 BEARING)
M-MFH15-U*-31	922995

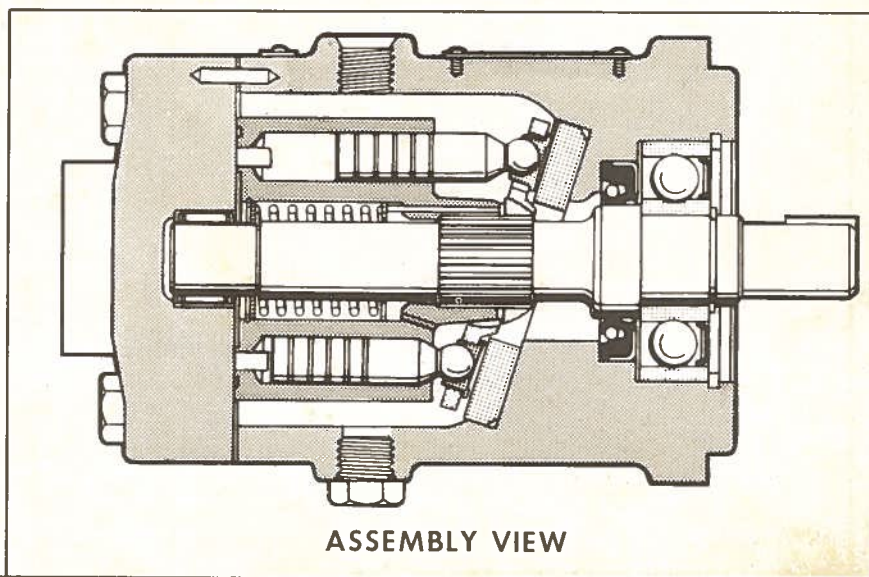




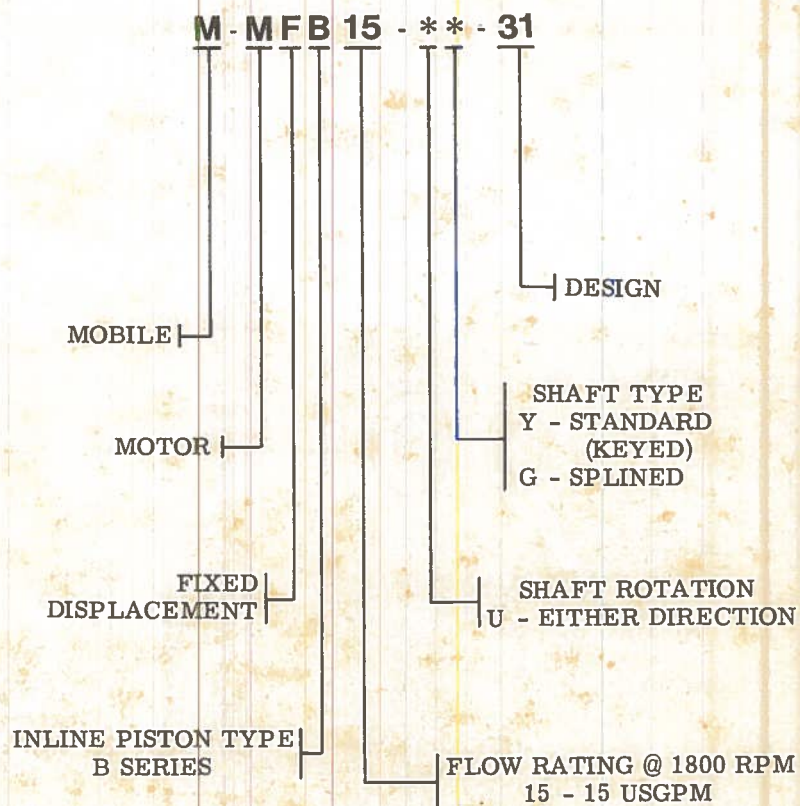
—●423324 SPHERICAL WASHER

●INCLUDED IN
922996 ROTATING
GROUP KIT

▲INCLUDED IN
919521 SEAL KIT



MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 19/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

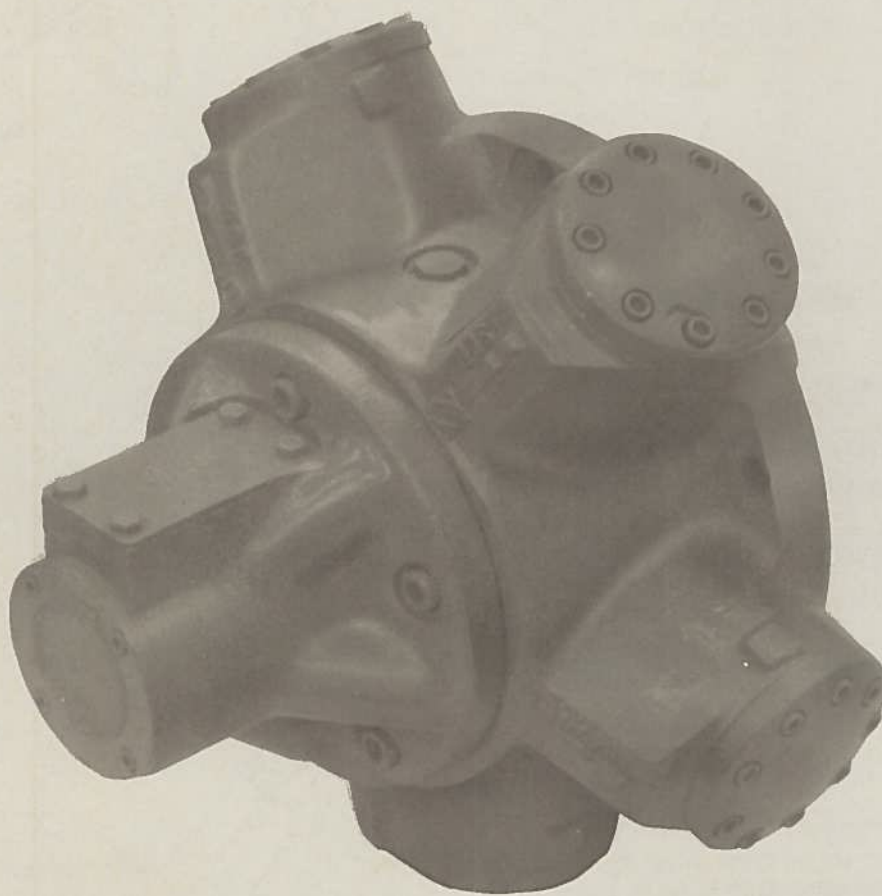
Litho in U.S.A.

VICKERS

Service Parts Information

Staffa
High Torque
Low Speed
Hydraulic Motor

HMB-080-*- (R)-10

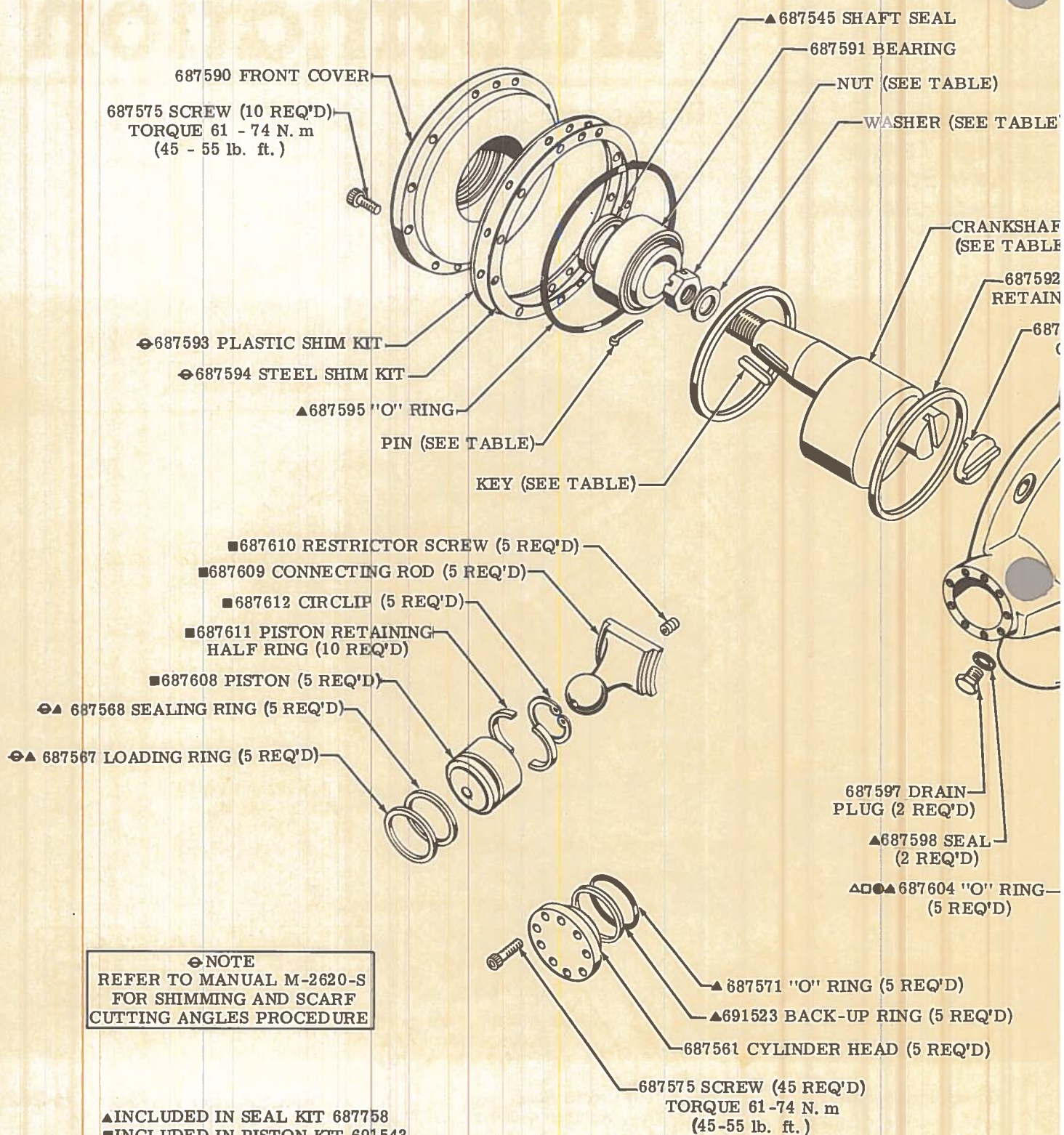


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RELEASED 7-1-86

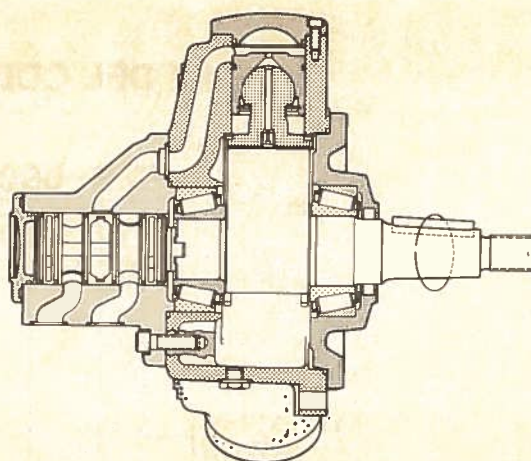
M-2625-S



NOTE
REFER TO MANUAL M-2620-S
FOR SHIMMING AND SCARF
CUTTING ANGLES PROCEDURE

- ▲ INCLUDED IN SEAL KIT 687758
- INCLUDED IN PISTON KIT 691543
(FOR ONE CYLINDER BORE)
- INCLUDED IN STD VALVE KIT 687599
- INCLUDED IN SAE (F) VALVE KIT 501109
- △ INCLUDED IN SAE (FM) VALVE KIT 501112

CRANKSHAFT	NUT	PIN	WASHER	KEY
687614 TAPER	687618	687616	687617	687615
501103 PARALLEL	—	—	—	691542
687613 SPLINE	—	—	—	—



SECTIONAL VIEW HMB-080

CONNECTING ROD
BUSHING (2 REQ'D)

LDHAM
BUSHING

687589 MOTOR
HOUSING

687570 BEARING

△□▲687605 "O" RING

▲●687604 "O" RING (2 REQ'D)

●687600 VALVE HOUSING

●687564 VALVE SPOOL

◇▲●687569 VALVE RING (12 REQ'D)

▲●687573 "O" RING

●687602 END CAP

NAMEPLATE

●687607 SCREW (5 REQ'D)
TORQUE 263-319 N. m
(195 - 235 lb. ft.)

●687606 SCREW (4 REQ'D)
TORQUE 30 - 44 N. m
(22 - 32 lb. ft.)

△□SAE HOUSING (SEE TABLE)

△□501106 VALVE SPOOL

▲◇▲△687569 VALVE RING (12 REQ'D)

▲▲△687573 "O" RING

△□501104 END CAP

NAMEPLATE

▲△687606 SCREW (4 REQ'D)
TORQUE 30 - 44 N. m
(22 - 32 lb. ft.)

687607 SCREW (5 REQ'D)
TORQUE 263-319 N. m
(195 - 235 lb. ft.)

"O" RING (SEE TABLE)

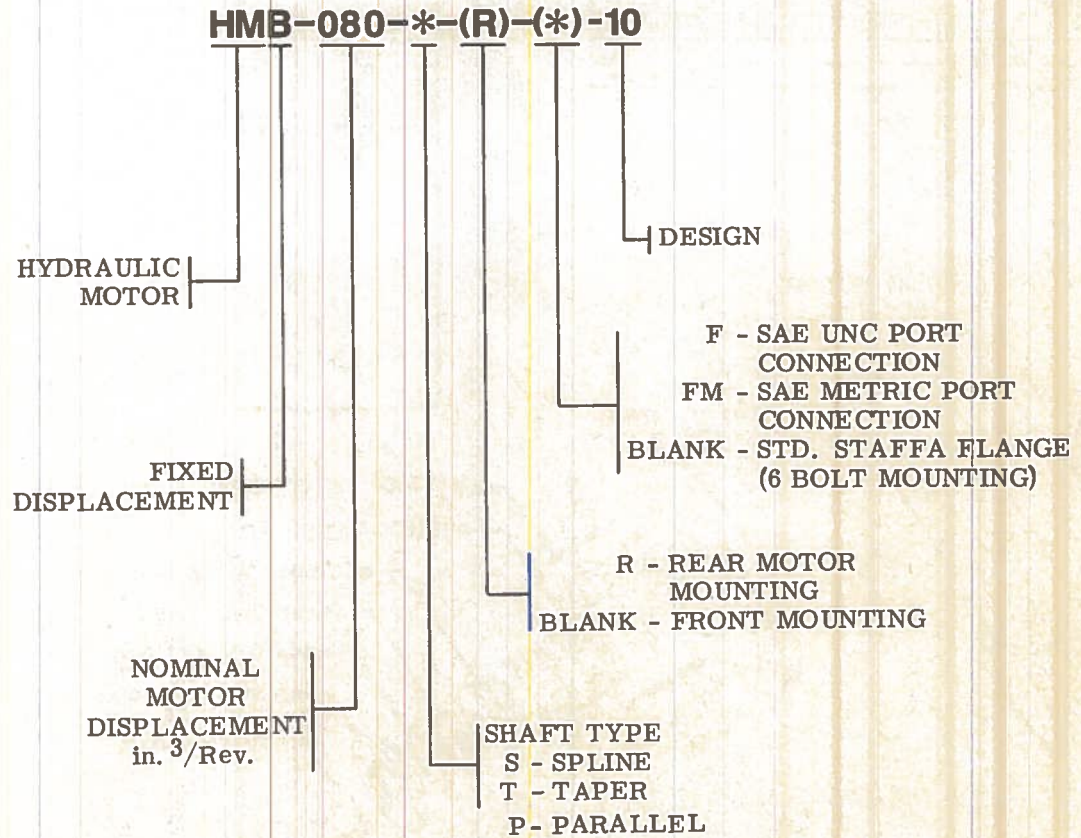
△□PLUG (SEE TABLE)

VALVE RING INSTALLATION
INSTALL CHAMFER ON EACH
RING NEXT TO WALL OF
GROOVE AS SHOWN



SAE	HOUSING	PLUG (2 REQ'D)	"O" RING (2 REQ'D)
UNC	501105	501108	501107
METRIC	501110	501111	—

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

VICKERS

Service Parts Information

**Staffa
High Torque
Low Speed
Hydraulic Motor**

HMB-100-*(F)-10

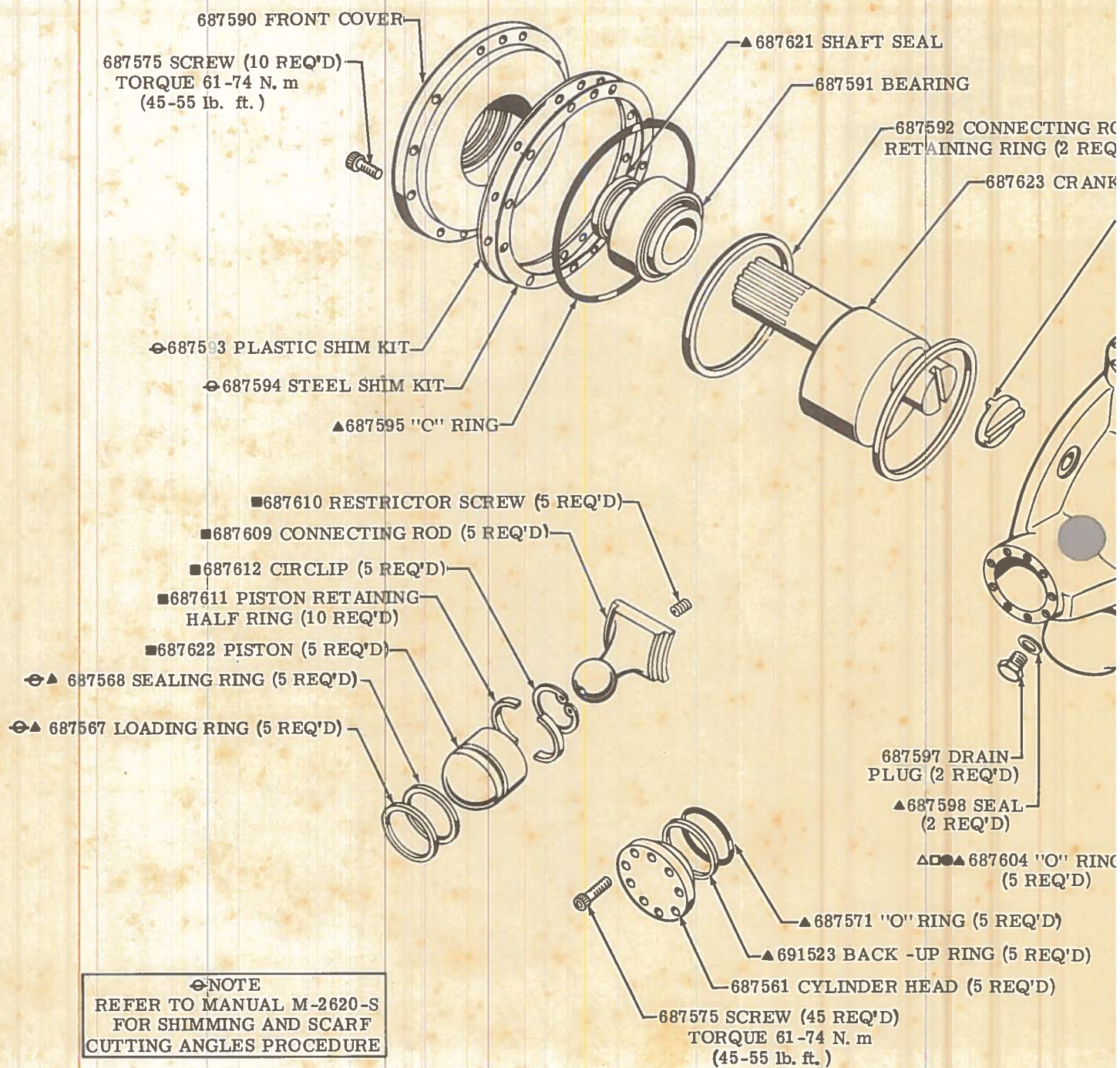


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M-2626-S



- ▲ INCLUDED IN SEAL KIT 687759
- INCLUDED IN PISTON KIT 691598
(FOR ONE CYLINDER BORE)
- INCLUDED IN STD VALVE KIT 687599
- INCLUDED IN SAE (F) VALVE KIT 501109
- △ INCLUDED IN SAE (FM) VALVE KIT 501112

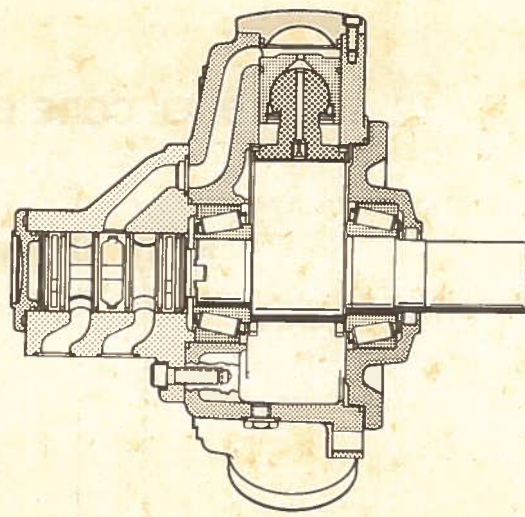
T

39 OLDHAM COUPLING

687619 MOTOR HOUSING

687570 BEARING

▲□●687605 "O"RING



SECTIONAL VIEW HMB-100

687607 SCREW (5 REQ'D)
TORQUE 263-319 N. m
(195 - 235 lb. ft.)

●▲687604 "O" RING (2 REQ'D)

●687600 VALVE HOUSING

●687564 VALVE SPOOL

●●▲687569 VALVE RING (12 REQ'D)

●▲687573 "O" RING

●687602 END CAP

NAMEPLATE

●687606 SCREW (4 REQ'D)
TORQUE 30-44 N. m
(22 - 32 lb. ft.)

VALVE RING INSTALLATION
INSTALL CHAMFER ON EACH
RING NEXT TO WALL OF
GROOVE AS SHOWN



▲□SAE HOUSING (SEE TABLE)

▲□501106 VALVE SPOOL

▲●▲□687569 VALVE RING (12 REQ'D)

▲▲□687573 "O" RING

▲□501104 END CAP

NAMEPLATE

▲□687606 SCREW (4 REQ'D)
TORQUE 30-44 N. m
(22 - 32 lb. ft.)

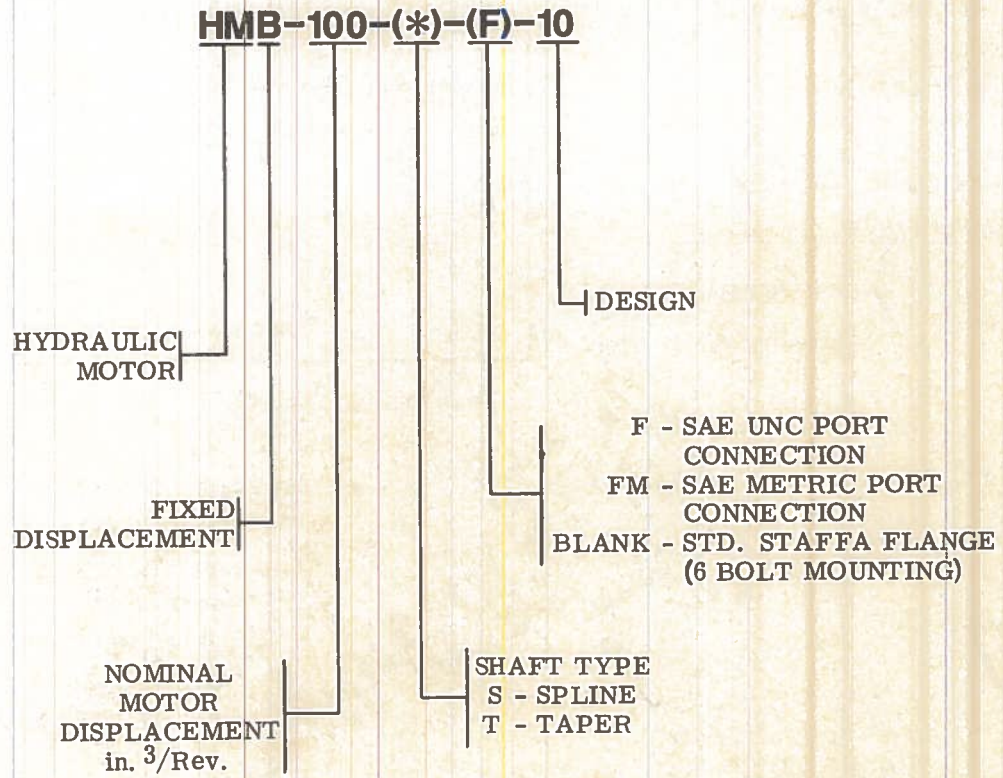
687607 SCREW (5 REQ'D)
TORQUE 263-319 N. m
(195 - 235 lb. ft.)

"O" RING (SEE TABLE)

▲□PLUG (SEE TABLE)

SAE	HOUSING	PLUG (2 REQ'D)	"O"RING (2 REQ'D)
UNC	501105	501108	501107
METRIC	501110	501111	—

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

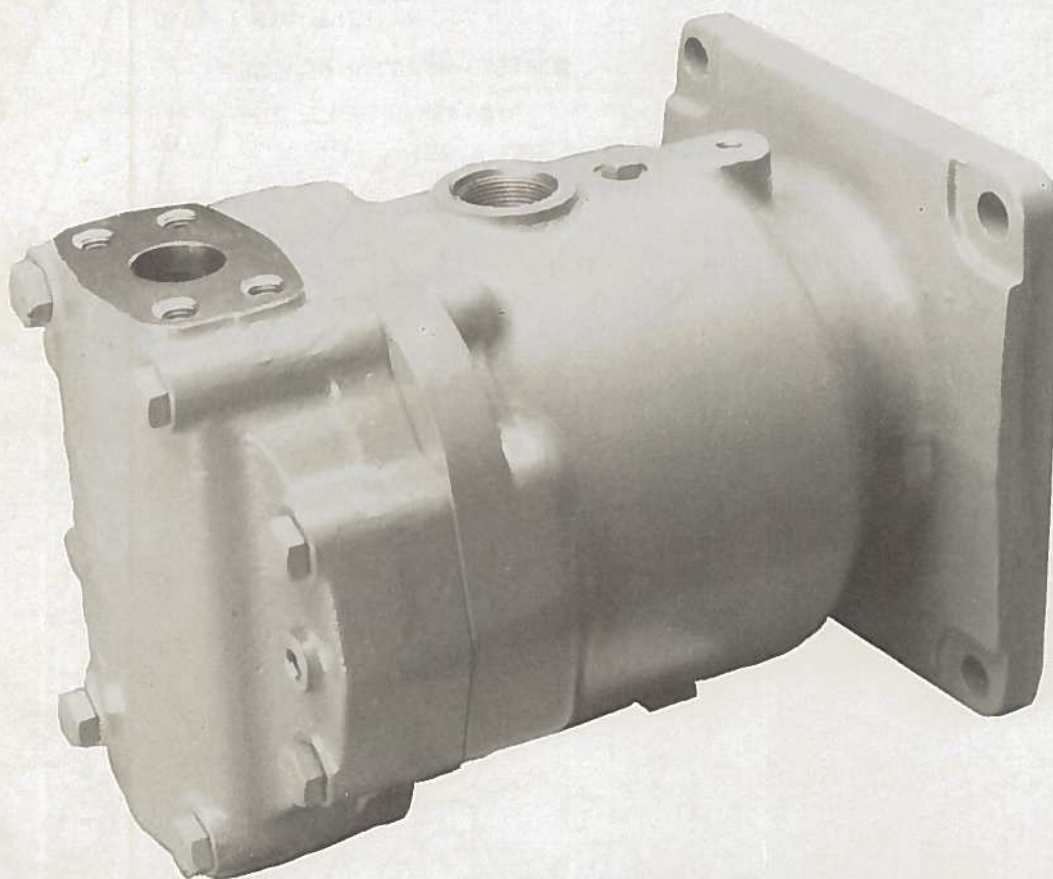
Litho in U. S. A.

VICKERS

Service Parts Information

**Fixed
Displacement
Piston
Motors**

MFD120-* -11
MFD120-* -E400-11

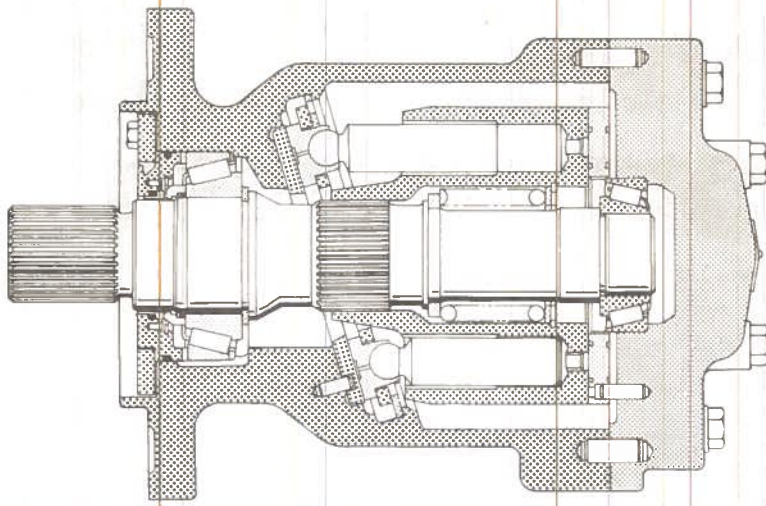


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Troy, Michigan 48064

Revised 11-1-85

M-2769-S



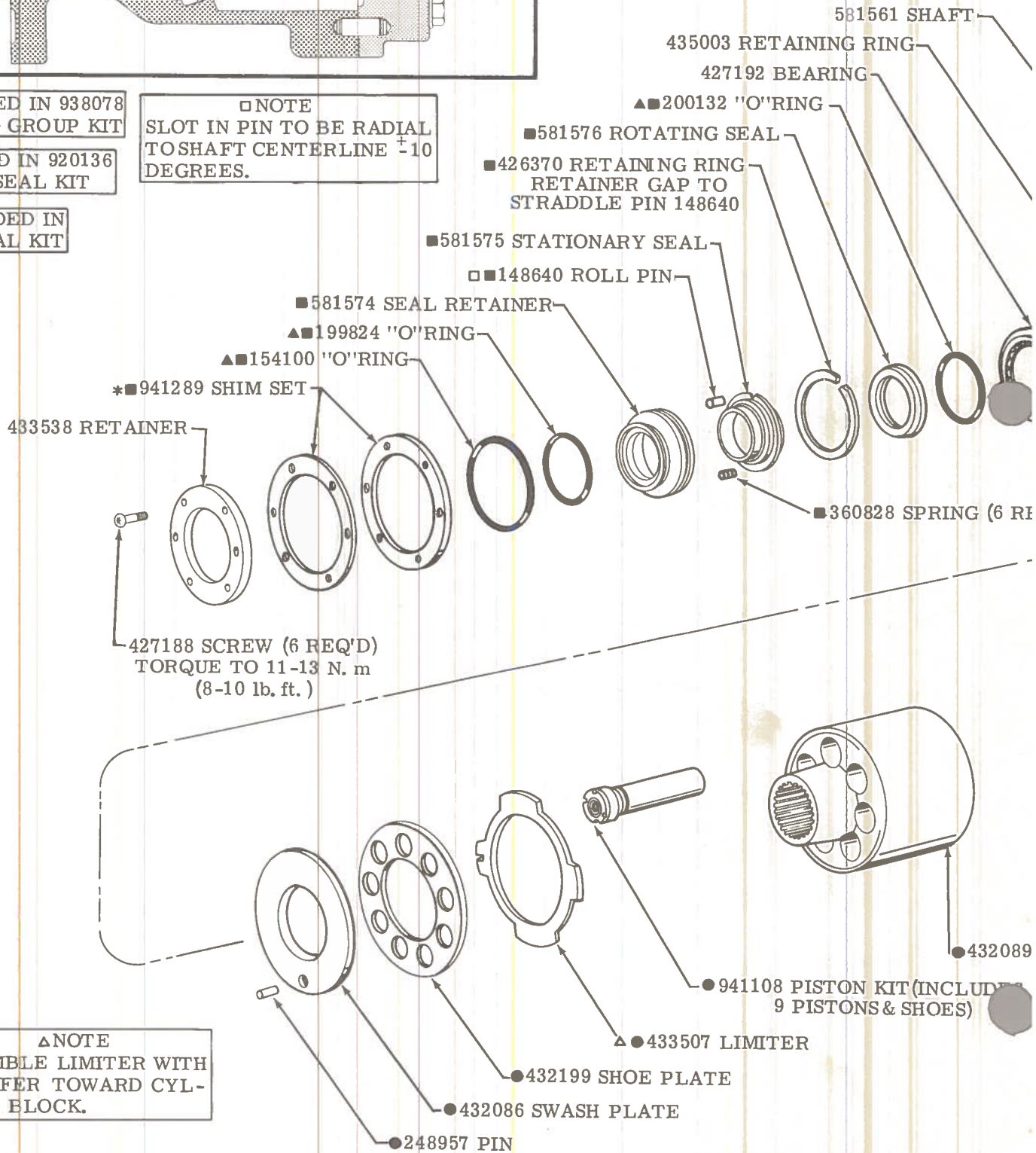
NOTE
SHAFT RUNOUT NOT TO
EXCEED 0.10 mm (0.004
INCH).

● INCLUDED IN 938078
ROTATING GROUP KIT

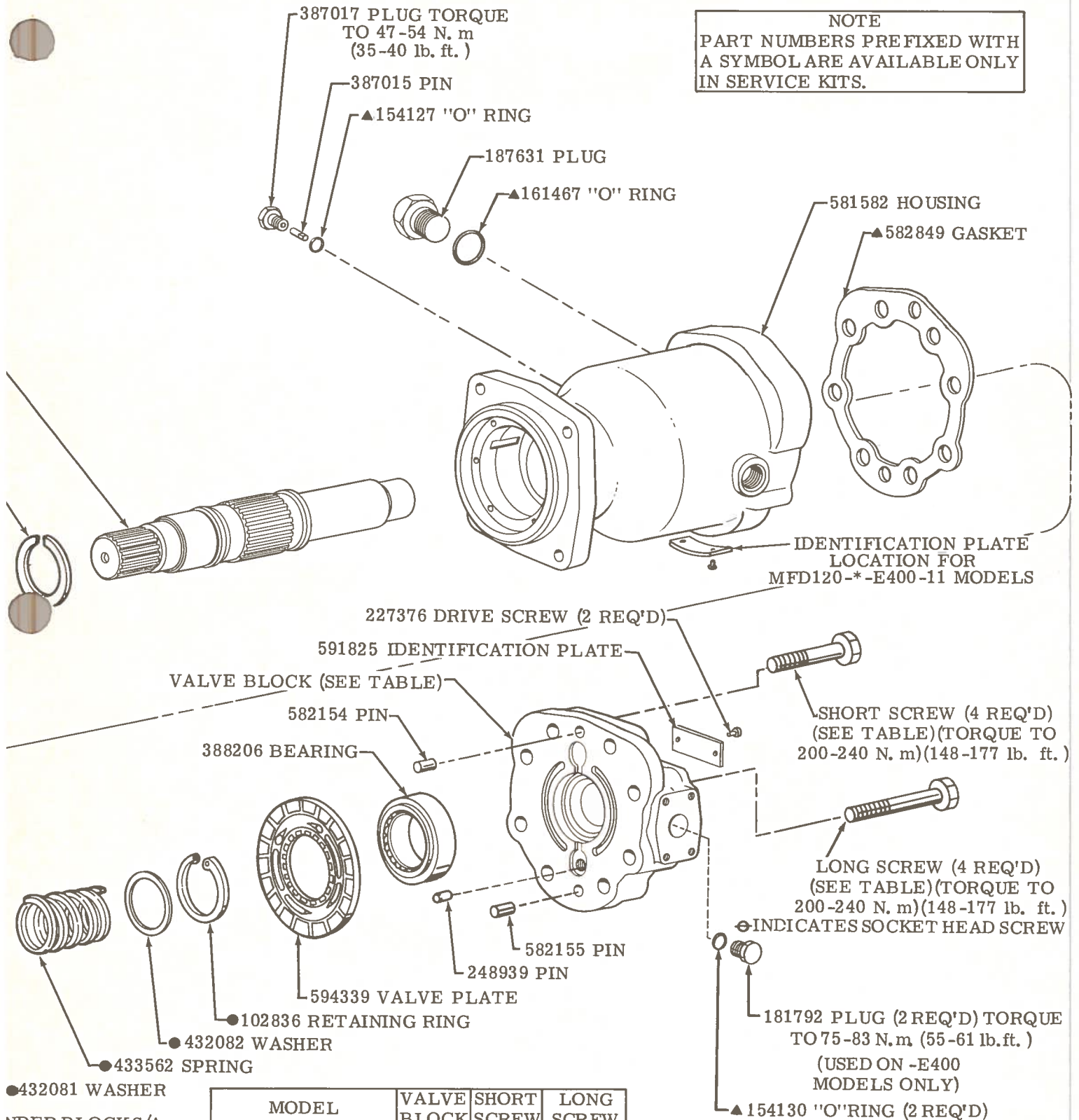
■ INCLUDED IN 920136
SHAFT SEAL KIT

▲ INCLUDED IN
920133 SEAL KIT

□ NOTE
SLOT IN PIN TO BE RADIAL
TO SHAFT CENTERLINE ± 10
DEGREES.



NOTE
PART NUMBERS PREFIXED WITH
A SYMBOL ARE AVAILABLE ONLY
IN SERVICE KITS.

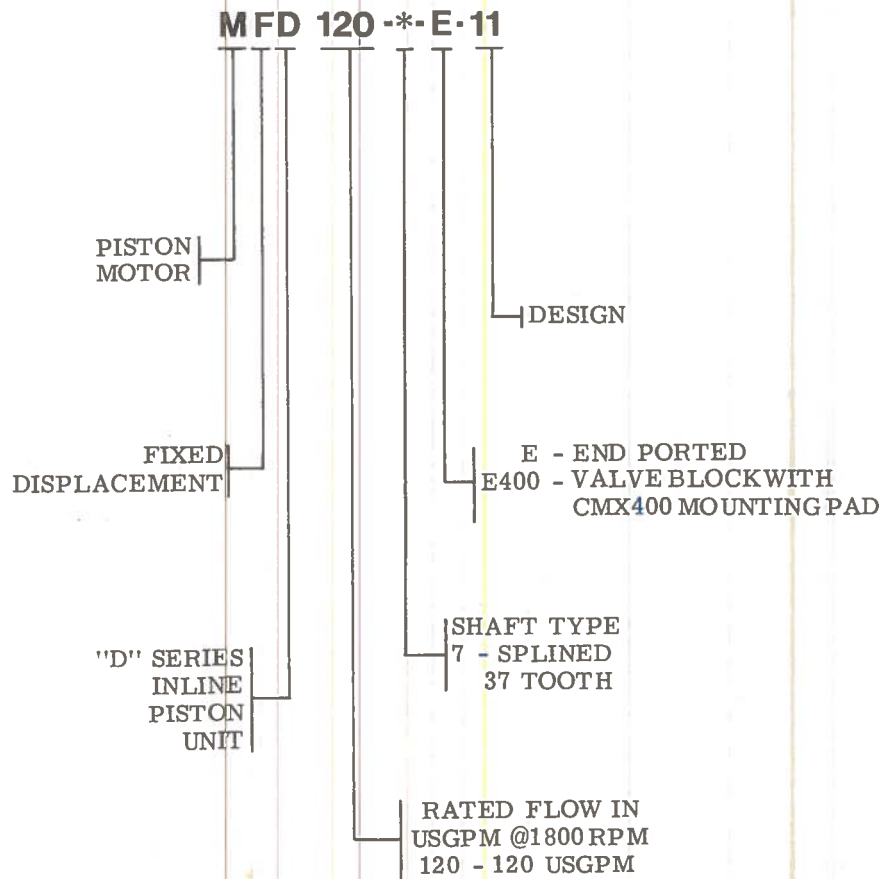


MODEL	VALVE BLOCK	SHORT SCREW	LONG SCREW
MFD120-*-11	581560	214771	214776
MFD120-*-E400-11	595499	214773	●298175

CAUTION
DO NOT GREASE SEAL PARTS. FLOOD
WITH CLEAN SYSTEM FLUID. "O" RINGS
MAY BE LUBRICATED WITH VISCOSITY
IMPROVER "STP" OR EQUIVALENT.

NOTE
*SHIM AS REQUIRED TO PROVIDE
0.025-.100 mm (0.001-0.004 INCH) SHAFT
END PLAY. SHAFT MUST BE ROTATED
UNDER PRELOAD TO ALIGN BEARING
ROLLERS AT BOTH ENDS BEFORE SET-
TING END PLAY.

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

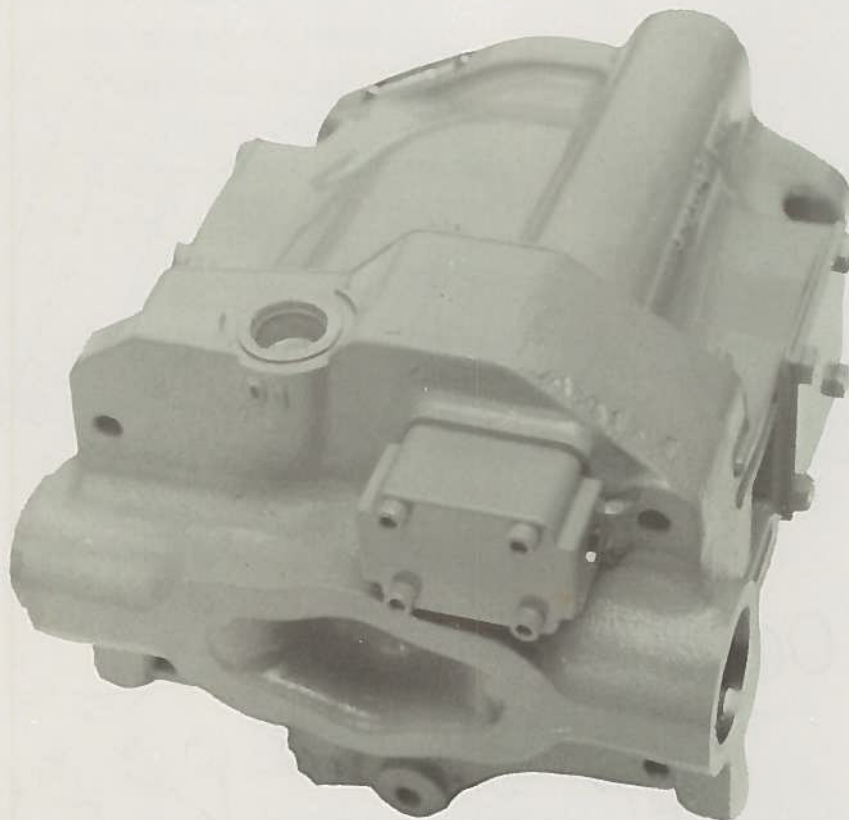
Litho in U. S. A.



Service Parts Information

**Dual
Displacement
Pilot Operated
Piston Motor**

MVE19-* -30-M** -10
MVE19-* -30-P* -10-030



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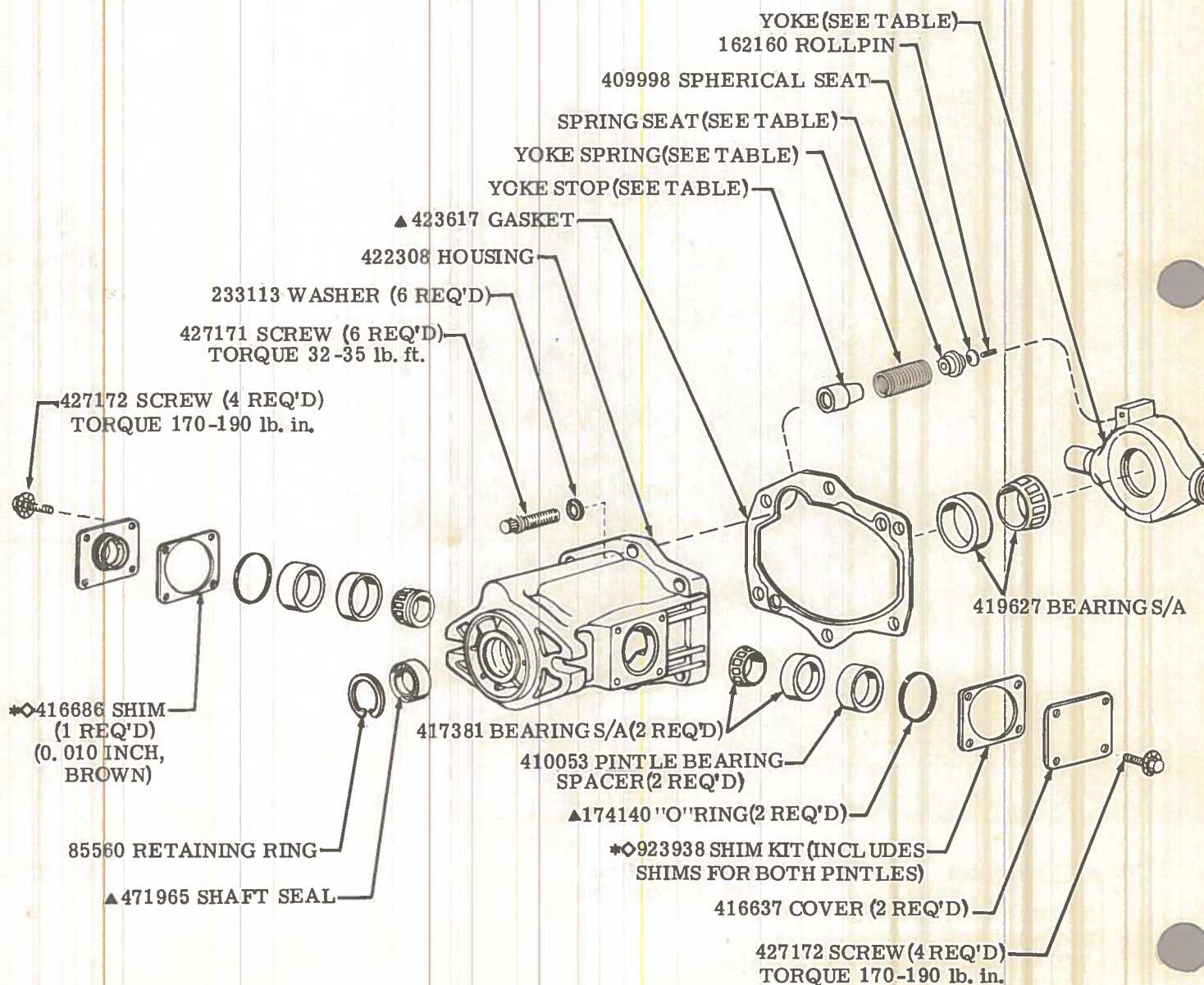
M-2822-S

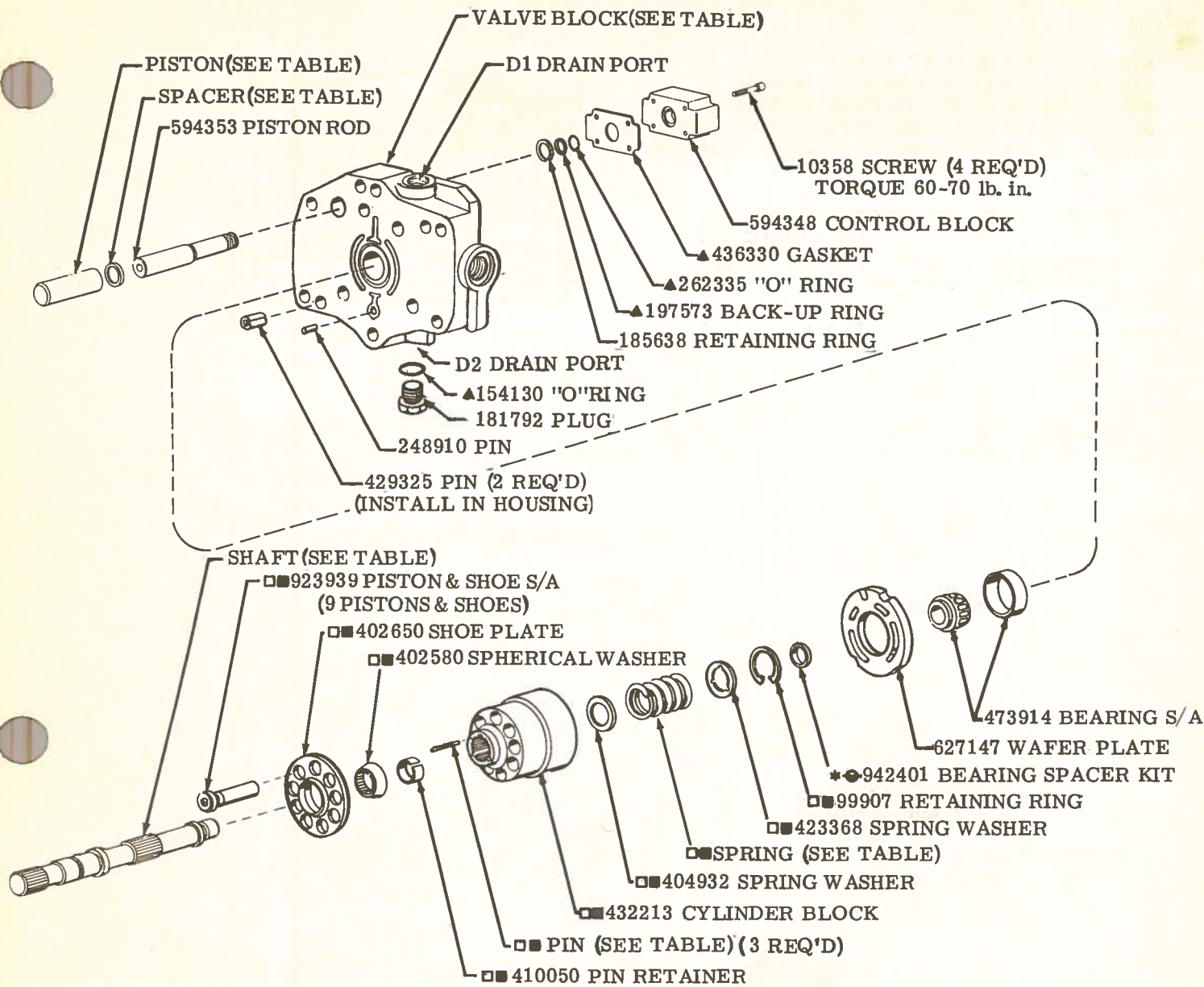
- ▲ INCLUDED IN SEAL KIT 920248
 ◇ INCLUDED IN PINTLE SHIM KIT 923938
 ⊕ INCLUDED IN BEARING SPACER KIT 942401
 ■ INCLUDED IN ROTATING GROUP (M**-10) 938092
 □ INCLUDED IN ROTATING GROUP (P**-10) 923941

MODEL	PORT	VALVE BLOCK
MVE19-*-30-**-10	SIDE	594346
MVE19-*-30-**-10-030	REAR	680780

MODEL	SPACER
MVE19-*-30-M0-10	OMIT
MVE19-*-30-M7-10	629521
MVE19-*-30-M9-10	629522
MVE19-*-30-M11-10	629523
MVE19-*-30-M13-10	629527
MVE19-*-30-M14-10	595487
MVE19-*-30-M15-10	629524
MVE19-*-30-P7-10	OMIT
MVE19-*-30-P9-10	

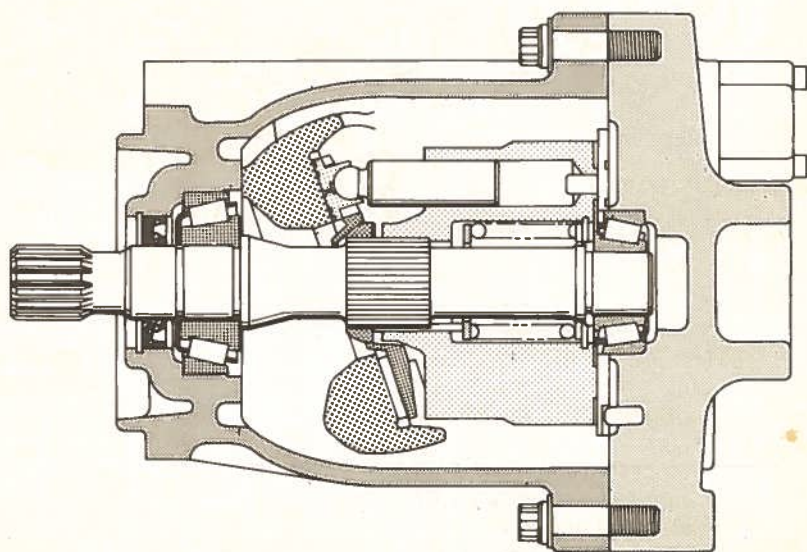
MODEL	YOKE STOP	YOKE SPRING	SPRING SEAT	YOKE	PISTON	PIN	SPRING
MVE19-*-30-M*-10	OMIT	594347	594355	594341	594354	393841	594799
MVE19-*-30-P7-10	581054	581075	581053	409997	404958	248810	418271
MVE19-*-30-P9-10			500572				



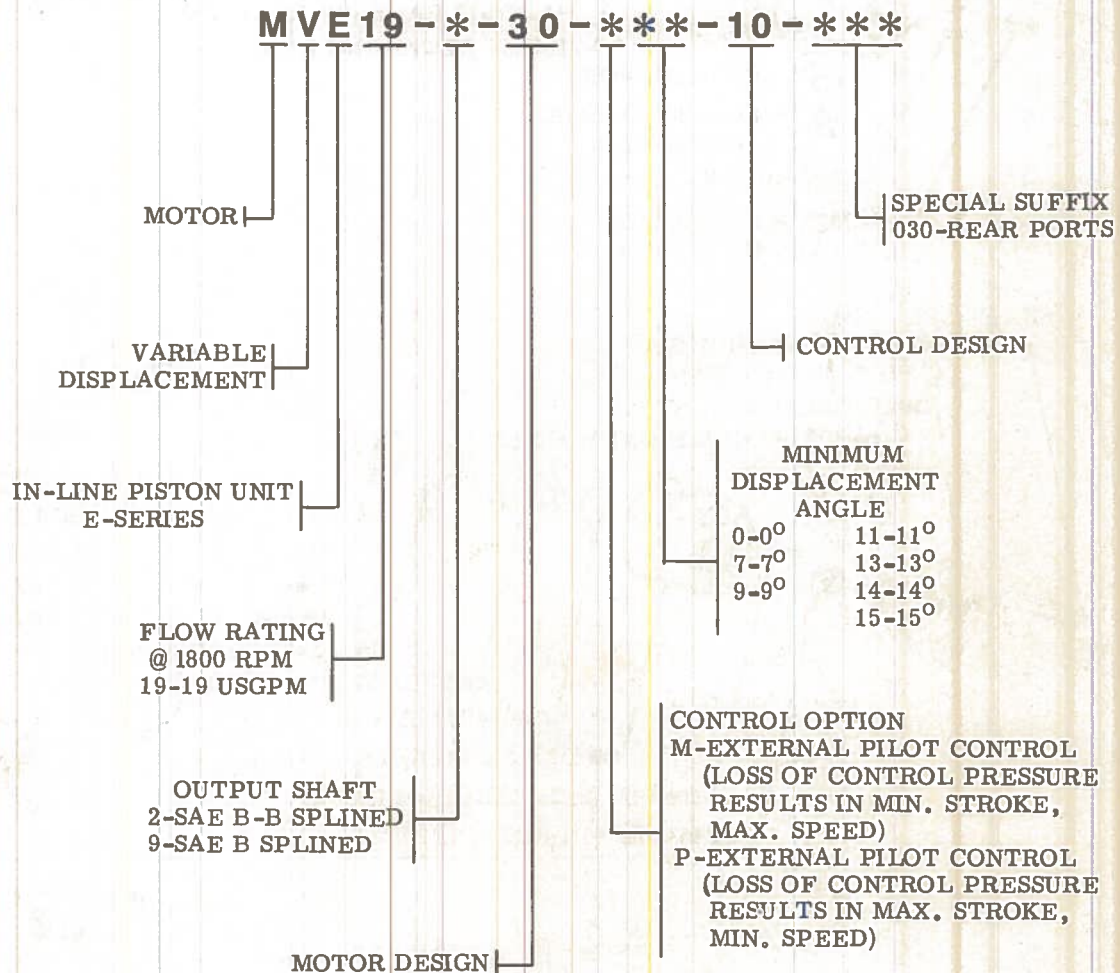


MODEL	SHAFT	SAE SHAFT TYPE
MVE19-2	423415	B-B SPLINED
MVE19-9	424544	B SPLINED

***NOTE**
REFER TO OVERHAUL MANUAL
M-2844-S FOR SHAFT END PLAY
AND PINTLE BEARING PRELOAD
SHIMMING PROCEDURE.



MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 19/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

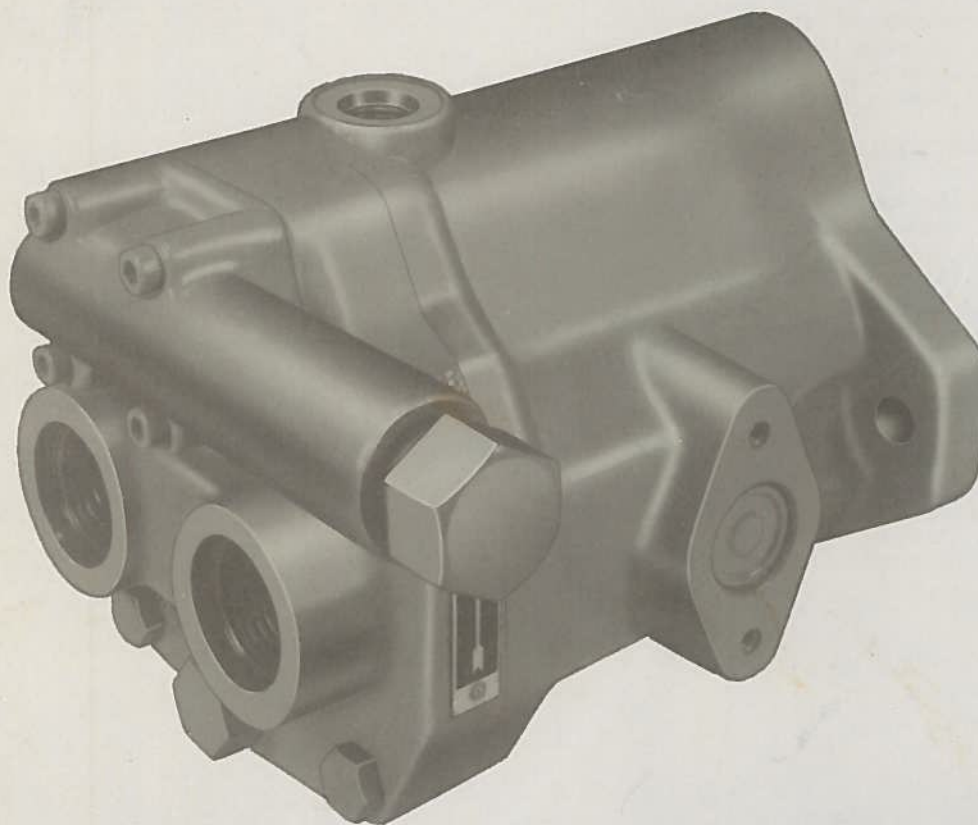


A TRIHIOVA COMPANY

Overhaul Manual

**Fixed & Variable
Displacement
Inline Piston
Pumps & Motors**

**MFB Series
MVB Series
P(M)FB Series
P(M)VB Series**



Vickers, Incorporated

1401 Crooks Road
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Revised 7-1-86

I-3230-S

SECTION

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Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual describes the basic operating characteristics and provides service and overhaul information for Vickers 282/283 suffix double vane pumps. The information contained herein pertains to the latest design series.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 1 are available

any Vickers sales representative or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

2. Model Codes - Variations within each basic model series are covered in the model code. Table 2 is a complete breakdown of the codes covering these units. Service inquiries should always include the complete unit model code number as stamped on nameplate located on housing.

MODEL	INSTALLATION DRAWING	PARTS DRAWING
M-MFB5 1	289420	I-3238-S
MFB5 2	520300	I-3238-S
MFB10 3	000324	I-3244-S
M-MFB15 4	000324	M-2765-S
M-MFB20 5	289420	M-2763-S
MFB20 6	000324	I-3247-S
M-MFB29 7	000324	M-2763-S
MFB29 8	520310	I-3741-S
MVB5 9	273831	I-3280-S
MVB10 10	273838	I-3268-S
M-MVB29 11	000324	M-2773-S
M-PFB5 12	289424	I-3238-S
PFB5 13	507725	I-3238-S
M-PFB10 14	289419	M-2202-S
PFB10 15	507727	I-3244-S
M-PFB15 16	289419	M-2202-S
M-PFB20 17	289426	M-2203-S
PFB20 18	507729	I-3247-S
M-PFB29 19	289426	M-2203-S
PVB5 20	508300	I-3280-S
PVB6 21	508300	I-3280-S
PVB6A 22	508275	I-3281-S
M-PVB10 23	289419	M-2212-S
PVB10 24	508400	I-3268-S
M-PVB15 25	000324	M-2212-S
PVB15 26	508400	I-3268-S
M-PVB20 27	000324	M-2213-S
PVB20 28	508500	I-3267-S
M-PVB29 29	000324	M-2213-S
PVB29 30	508500	I-3267-S
PVB45A 31	508890	I-3294-S

Table 1. Reference Material

MODEL CODE BREAKDOWN

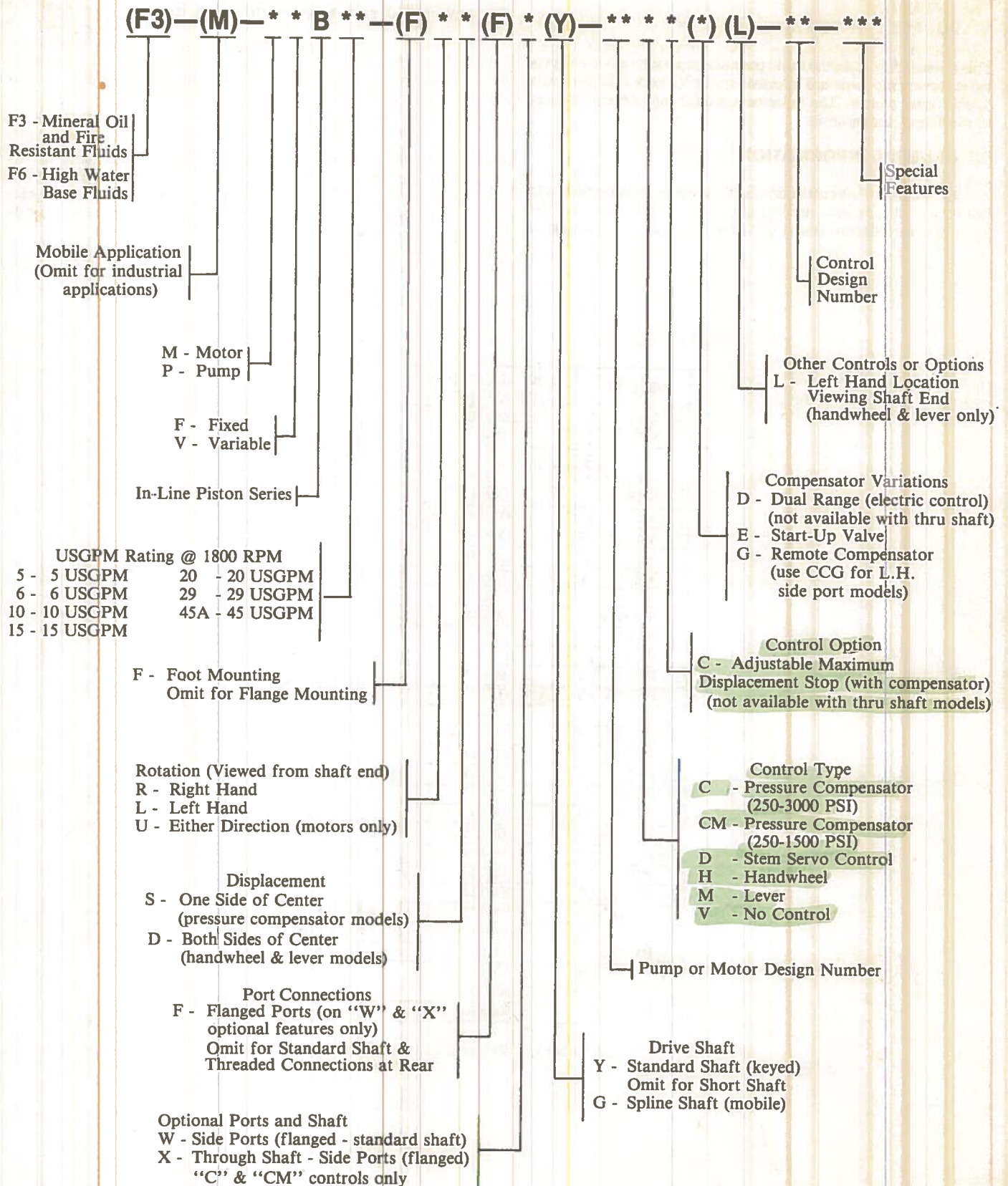


Table 2. Model Code Breakdown

Section II - DESCRIPTION

A. GENERAL

Vickers inline pumps and motors are of the axial piston, positive displacement type and include both fixed and adjustable (variable) displacement pumps and motors capable of high pressure operation. Drive speeds vary with the model, type of fluid used, and circuit application.

B. ASSEMBLY AND CONSTRUCTION

The assembly of typical fixed and variable displacement units

together with their A.N.S.I. symbols are shown in Figure 1. As illustrated, the major components of the inline unit are the housing, bearing-supported drive shaft, rotating group, swash plate and valve plate. The pressure compensated variable displacement units incorporate a pressure sensitive control piston, which governs the angle of the yoke and swash plate and consequently controls the stroke length of each piston as it rotates with the cylinder block and drive shaft. The valve plate subassembly also serves as the back cover of the entire unit and includes the inlet and outlet ports. A bearing in this cover and one in the housing support the drive shaft.

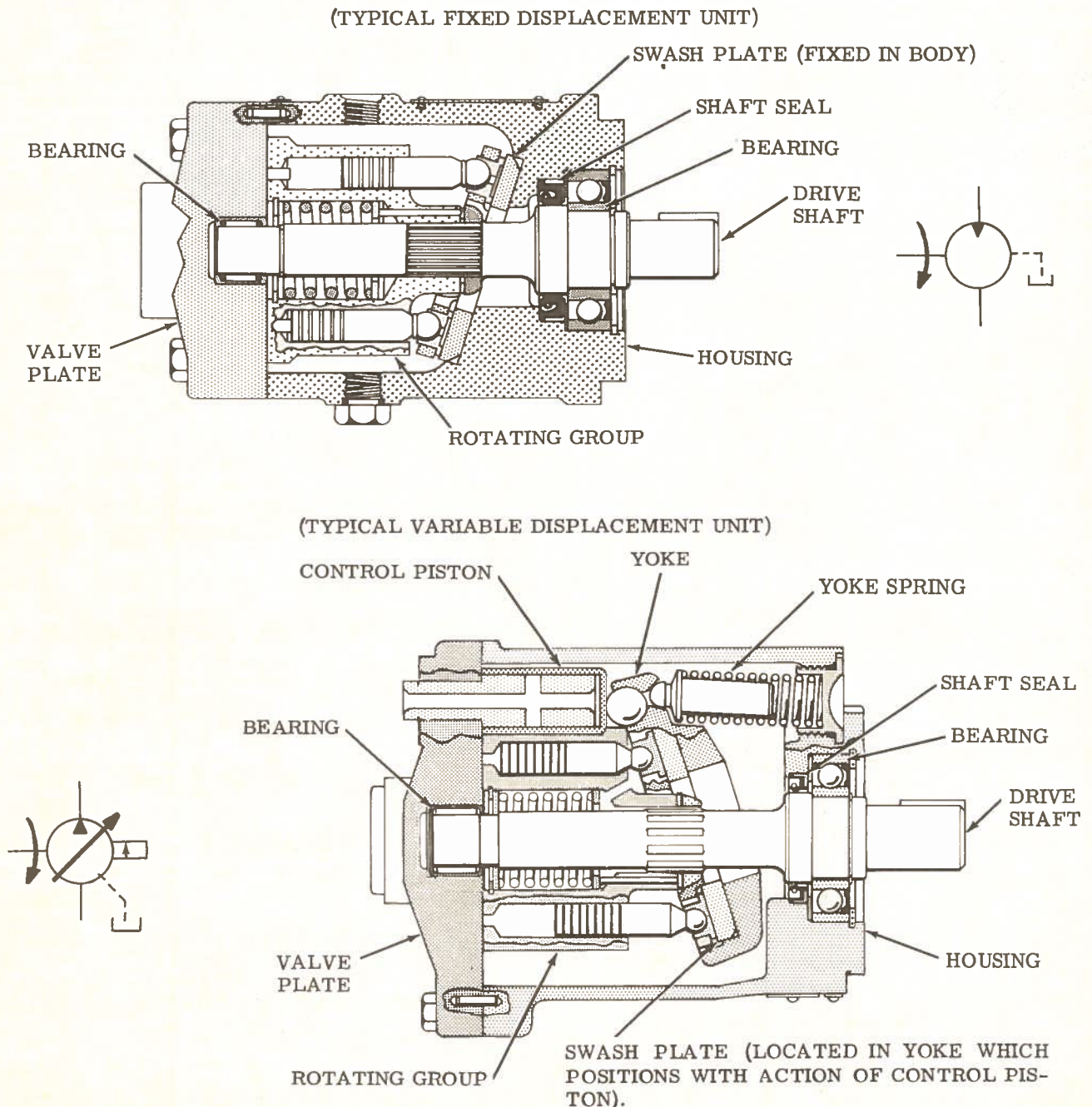


Figure 1. Typical Unit Assembly.

Section III - PRINCIPLES OF OPERATION

A. GENERAL

Although nearly identical in design, pumps and motors operate essentially in reverse of each other—the pump forcing fluid through the system as it rotates, the motor being rotated by the fluid. Variable displacement units are constructed so that the angle of displacement (angle of the swash plate to the drive shaft axis) can be varied by changing the yoke position.

B. MOTORS

Motors are positive displacement units which are capable of producing a variable torque and speed. Motor speed is a function of the input fluid volume and torque is a function of the input pressure. On a variable displacement motor, the angle of displacement (swash plate angle) also affects the speed and torque.

In operation, pressurized fluid is forced into the cylinder block bores which are open to the inlet port. Inlet pressure causes the pistons to exert a force against the swash plate. At the control point of the piston shoe and swash plate, a component of the angular counter-force causes the cylinder block to move in a rotary direction. The remaining cylinder block bores are either open to the outlet or blocked by the valve plate. When the pistons move across the outlet port, fluid discharges and returns to the reservoir or system.

Rotation is reversed by reversing the fluid supply to the motor or if the motor is a variable displacement type, it can be stroked across-center for reversal. If a variable unit is stroked across center, adequate precautions must be taken to prevent overspeed, overpressure and/or cavitation. "Stroking across center" means moving the swash plate from an angle on one side of center, to zero (center) angle of the yoke, and then to the opposite side of center.

Motors are used for continuous, intermittent, or continuously reversing service. They can be stalled indefinitely under load without damage when protected by a relief valve.

C. PUMPS

The operation of the pump is essentially in reverse of motor operation. During the time that a piston is moving out of the cylinder block bore, a pressure differential develops which forces fluid into the open cylinder block bores through the inlet port. As the cylinder block rotates past the outlet port, the pistons force fluid out into the system.

On variable displacement pumps, outlet volume is varied by changing the swash plate angle between the swash plate and the drive shaft axis. Since the swash plate angle is not variable on fixed displacement pumps, the flow is determined by pump size and speed driven (RPM).

Section IV - INSTALLATION

A. GENERAL

Installation drawings shown in Table 1 should be consulted for correct installation information.

B. MOUNTING AND DRIVE CONNECTIONS

CAUTION

Pump/motor shafts are designed to be installed in couplings with a slip fit. Pounding can injure the bearings. Shaft tolerances are shown on the installation drawings. (See Table 1.)

A pilot on the pump/motor mounting flange assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening the mounting screws to prevent misalignment.

Mount the unit with the drain line connection at the top. This will allow easy filling of the housing before start-up and also prevent draining of the housing in periods of idleness. There should be no restriction between the drain port and the reservoir. The drain line must terminate below reservoir fluid level.

C. INLET LINE

Inlet lines must have sufficient capacity to allow full flow requirements at the pump or motor inlet for all conditions of operation. The use of restrictive inlet tubing, undersize filter or an improper grade of fluid may result in inlet vacuum conditions exceeding the recommended five inches of mercury and cause cavitation in pumps. Cavitation is the rapid formation

and collapse of vapor pockets within the fluid and can cause excessive damage to the unit. Motor inlet lines must be of the high pressure type to withstand the output pressure of the associated pump. Check the appropriate installation drawing for maximum motor/pump speed. (See Table 1.)

D. FILTRATION

Vickers recommends the use of inlet, pressure and/or return line filtration. Inlet filters can be supplied with magnets and a contamination indicator or an electrical switch. The electrical switch feature can be used to actuate an alarm when the filter element is plugged. Vickers field engineering personnel should be consulted when unusual fluids or viscosity conditions are encountered.

E. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling.

NOTE

For instructions on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

F. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps and motors. Any oil selected for use with pumps is acceptable for use with valves or motors.

Data sheet I-286-S for oil selection is available from Vickers Technical Publications, Troy, Michigan 48084.

Oil recommendations noted in the data sheet is based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales engineer.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean.

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of oil to prevent introduction of contaminants into the system.
3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.
5. During usage, proper oil filling and servicing of oil filters, breathers, reservoirs, etc., cannot be over emphasized.
6. Thorough precautions should be taken by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in hydraulic systems are:

1. Very high viscosities at start-up temperatures can cause noises due to cavitation.
2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.
3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity in discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

G. OVERLOAD PROTECTION

Both fixed and compensated pumps require an external relief valve to provide maximum protection of circuit components. An external relief valve is also required in the inlet line of a hydraulic motor to limit the pressure and torque.

H. STARTING AND PRIMING

Before initial starting, fill the housing with clean fluid. Normal "leakage" past the pistons or between the cylinder block and valve plate provides internal lubrication of working parts. To assure initial priming of variable displacement units, adjust the controls to provide at least 40% of maximum displacement at start-up. The control may be reset to a lower displacement after priming is accomplished.

It may be necessary to bleed air from the pump outlet line to permit priming and reduce noise. Bleeding may be accomplished by loosening an outlet connection until a solid stream of fluid appears. An automatic air bleed valve (ABT-02-10) can be permanently installed and will eliminate the necessity to loosen a connection.

Section V - SERVICE AND MAINTENANCE

A. SERVICE TOOLS

The following standard tools are required for overhaul of a piston type pump or motor:

1. Torque wrench with socket adapters
2. Set of U.S. hex key wrenches
3. Set of small pin punches
4. 3/8 inch socket set with ratchet
5. Small ball peen hammer
6. Steel scale
7. Micrometer (0-1 inch)
8. Dial indicator

An arbor press is also required for assembly of shaft and pintle bearings.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be cleaned regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher than normal pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the bypass to open, resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin the pump and other components. If bubbles are seen, locate the source of the air and seal the leak.

5. A pump or motor which is running excessively hot or noisy is a potential failure. Should a unit become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance

which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation through the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacture of our parts. Substitutions may result in early failure. Part numbers are shown in the parts drawings listed in Table 1.

G. TROUBLESHOOTING

Table 3 lists the common difficulties experienced with piston pumps and motors. It also indicates probable causes and remedies for each of the troubles listed.

Section VI - OVERHAUL

A. GENERAL

CAUTION

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

After removing pump or motor from system and before disassembly, cap or plug all ports and disconnected lines. Clean the outside of the unit thoroughly to prevent entry of dirt into the system.

CAUTION

Absolute cleanliness is essential when working on a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Discard and replace all "O" rings, gaskets and shaft seals removed during disassembly.

B. DISASSEMBLY

All models are disassembled in the same general sequence as shown in the exploded view, Figure 2.

NOTE

This procedure is written for a basic compensator model. If a control other than a compensator is used, refer to the appropriate service parts drawing for information on the control.

Parts should be placed on a clean piece of Kraft paper in the order of disassembly.

1. Remove four screws (1) from compensator body (2).
2. Remove compensator body (2) from valve plate subassembly (7).
3. Remove gasket (3), "O" ring (4) and retaining ring (5) from piston rod (9).
4. Remove six screws (6) from valve plate subassembly (7).
5. Remove valve plate subassembly (7) from housing (36). Place valve plate subassembly on a clean piece of Kraft paper with machined surface up. Remove piston rod (9), spacer (10) and piston (11) from valve plate (7). (Note: Spader does not exist in all models.)
6. Remove gasket (8) and discard.

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	Reservoir fluid level low. Intake filter or pipe plugged. Air leak in intake line prevents priming. Coupling or shaft sheared or disengaged. Pump driven in wrong direction of shaft rotation.	Add fluid and check level on both sides of reservoir baffle to insure pump intake line is submerged. Clean filters of lint soon after new fluid is added. Pour fluid on intake joints while listening for change in sound of operation. Tighten as required. Disassemble pump and check shaft and rotating group for damage. Replace necessary parts. Check installation. Reverse the drive or convert pump as discussed in the overhaul section.
SYSTEM NOT DEVELOPING PRESSURE	Contamination in actuating control. Pump not delivering fluid for any of the above reasons. Relief valve setting not high enough. Relief valve sticking open. Leak in hydraulic control system (cylinders or valves). Free circulation of fluid to reservoir.	Clean control Check circulation by watching fluid in reservoir. Block machine travel. Test with pressure gauge. Remove contamination in relief valve. Test independently by progressively blocking off the circuit. Insure that directional valve is not in open center (neutral) position or that fluid is not discharging to tank through an open line or improperly adjusted valve.
PUMP MAKING NOISE	Partly clogged intake line, intake filter, or restricted intake pipe. Air leak at pump intake pipe joints. Air bubbles in fluid. Reservoir air vent plugged. Pump running too fast. Filter too small on intake. Coupling misalignment.	Pump must receive intake fluid freely or cavitation takes place. Tighten as required. Pour fluid on joints while listening for change in sound of operation. Check to be certain return lines are below fluid level and well separated from intake line. Must be open through breather opening or air filter. Conform with recommended maximum speeds on installation drawings. Refer to appropriate installation drawing for proper size filter. Check for damaged shaft bearing or other parts. If necessary, replace and realign the coupled shafts.
MOTOR SHAFT DOES NOT TURN. INSUFFICIENT SPEED OR POWER.	System overload relief valve set too low to permit necessary pressure. Valve plate and cylinder block surface scored by abrasive in hydraulic fluid.	Check pressure and increase relief valve setting, but not above recommended maximum. Check external leakage at drain port. Remove motor. Install new rotating group. Replace scored valveplate. Flush system with clean oil.
MOTOR TURNING IN WRONG DIRECTION	Pump or other components in system not functioning properly. Incorrect connection.	Check directional control and pump stroke position. Check circuit and connect correctly.
EXTERNAL LEAKAGE FROM MOTOR	Worn seal or gaskets. Gaskets leaking due to improperly connected reservoir drain.	Install new seal and/or gaskets. Connect drain line directly to reservoir below the fluid level.
SPEED FLUCTUATIONS WITH CONSTANT INPUT FLOW	Irregular wear between valve plate and cylinder block.	Replace damaged parts.

Table 3. Troubleshooting Pumps/Motors

7. The rotating group consists of retaining ring (12), lift limiter (13), spring (14), thrust washer (15), cylinder block (16), pins (17), backup washer (18), spherical washer (19), shoe plate (20) and piston/shoe subassembly (21). Turn the rotating group slightly to free it from the swash plate (22). Tilt housing

(36) and remove the rotating group. During removal, use care to prevent separation of the rotating group. Disassemble the rotating group as follows: (Refer to Figures 2 and 3 during disassembly.)

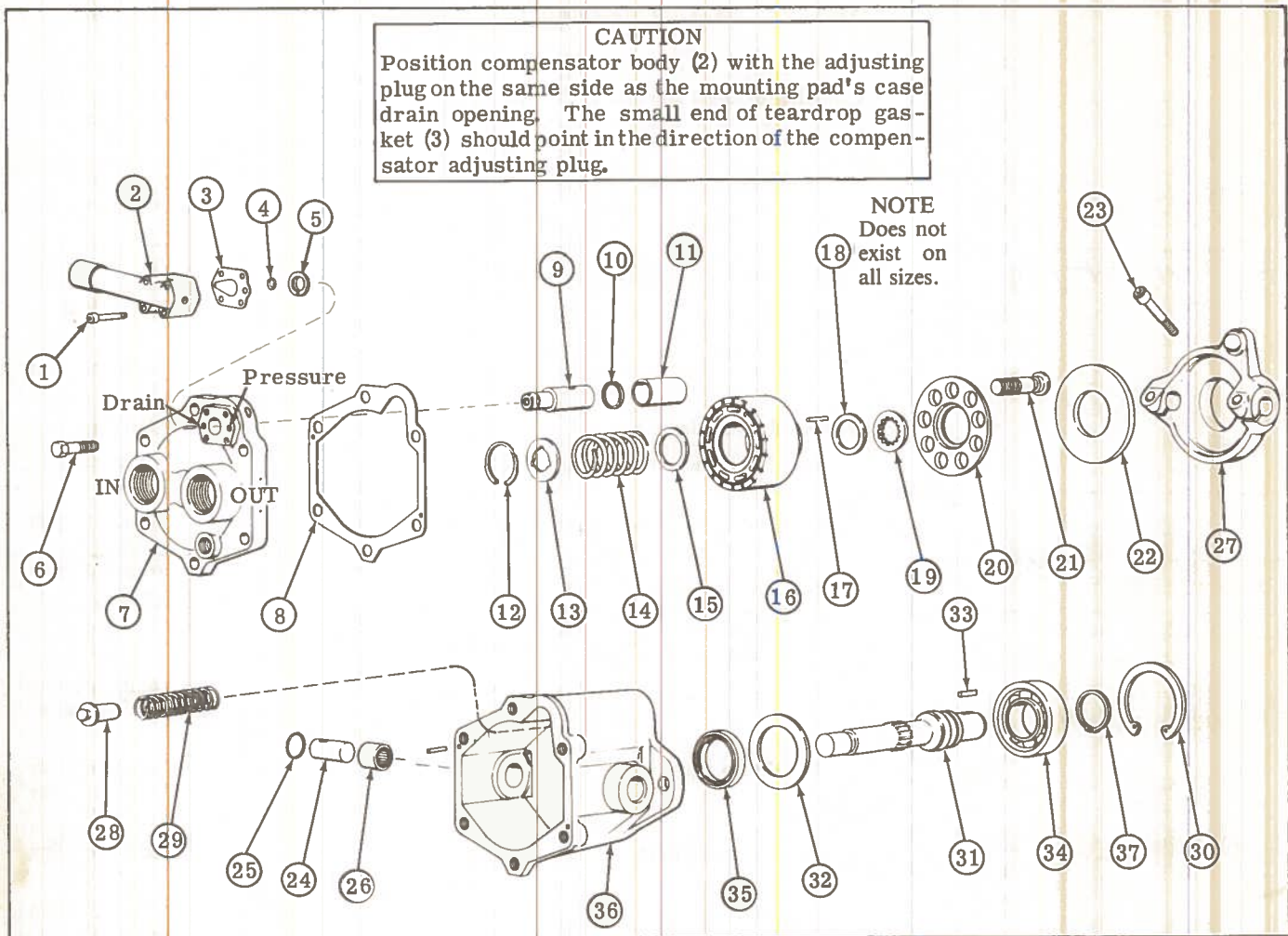


Figure 2. Exploded Parts Breakdown

ITEM	NOMENCLATURE	QTY.	ITEM	NOMENCLATURE	QTY.
1	Screw (Compensator)	4	19	Spherical Washer	1
2	Body (Compensator)	1	20	Shoe Plate	1
3	Gasket (Compensator)	1	21	Piston/Shoe Subassembly	9
4	"O" Ring (Compensator)	1	22	Swash Plate	1
5	Retaining Ring (Compensator)	1	23	Screw (Yoke)	2
6	Screw	6	24	Pintles	2
7	Valve Plate	1	25	"O" Ring (Pintle)	2
8	Gasket	1	26	Bearing (Pintle)	2
9	Piston Rod	1	27	Yoke Subassembly	1
10	Spacer	1	28	Seat	1
11	Piston	1	29	Spring	1
12	Retaining Ring	1	30	Retaining Ring	1
13	Lift Limiter Washer	1	31	Drive Shaft	1
14	Spring	1	32	Shaft Seal Retainer	1
15	Thrust Washer	1	33	Drive Shaft Key	1
16	Cylinder Block	1	34	Bearing (Drive Shaft)	1
17	Pin	3	35	Shaft Seal	1
18	Backup Washer	1	36	Housing	1
			37	Retaining Ring (Bearing)	1

Figure 2. Part Nomenclature

(M)-MFB SERIES

Diagram illustrating the assembly components and sequence for the (M)-MFB SERIES engine. The components are labeled as follows:

- SCREW (2 REQ'D)
- NAMEPLATE
- SNAP RING
- BEARING
- SHAFT
- WASHER
- SEAL
- WASHER
- SPHERICAL WASHER
- PIN (3 REQ'D)
- CYLINDER BLOCK
- LIFT LIMITER
- SNAP RING
- GASKET
- BEARING
- VALVE PLATE S/A
- SCREW (4 REQ'D)
- PLATE
- SCREW (2 REQ'D)
- PLATE
- "O" RING
- PLUG
- PIN
- WASHER
- SPRING
- SWASH PLATE
- HOUSING
- PISTON S/A (9 REQ'D)

The diagram shows the exploded view of the engine components, with dashed lines indicating the assembly sequence and alignment of parts.

Figure 2a. Typical Fixed Displacement Motor

(M)-MVB SERIES

The diagram illustrates the exploded view of the MVB Series compensator assembly. Key components are labeled as follows:

- BEARING (2 REQ'D)**, **PINTLES (2 REQ'D)**, **"O" RING (2 REQ'D)**, **PISTON S/A (9 REQ'D)**, **SWASH PLATE**, **PIN (2 REQ'D)**, **SCREW (2 REQ'D) PLATE**, **VALVE PLATE S/A**, **PISTON ROD**, **GASKET**, **"O" RING**, **PLUG**, **SCREW (4 REQ'D)**, **BODY (SEE CAUTION)**, **SPOOL**, **SEAT**, **SPRING**, **"O" RING**, **PLUG**.
- YOKE**, **NAMEPLATE**, **HOUSING**, **SCREW (2 REQ'D)**, **SEAT**, **SPRING**, **"O" RING**, **RING PLUG**, **SNAP RING**, **BEARING**, **SHAFT**, **WASHER**, **SEAL**.
- GASKET PISTON**, **Pressure Drain**, **OUT IN.**, **SPACER**, **BEARING**, **SCREW (2 REQ'D)**, **ROTATION PLATE**, **CYLINDER BLOCK**, **WASHER**, **SPRING**, **LIFT LIMITER**, **SNAP RING**.

CAUTION

Position the compensator body with the adjusting plug on the same side as the mounting pad's case drain opening.

Figure 2b. Typical Variable Displacement Motor

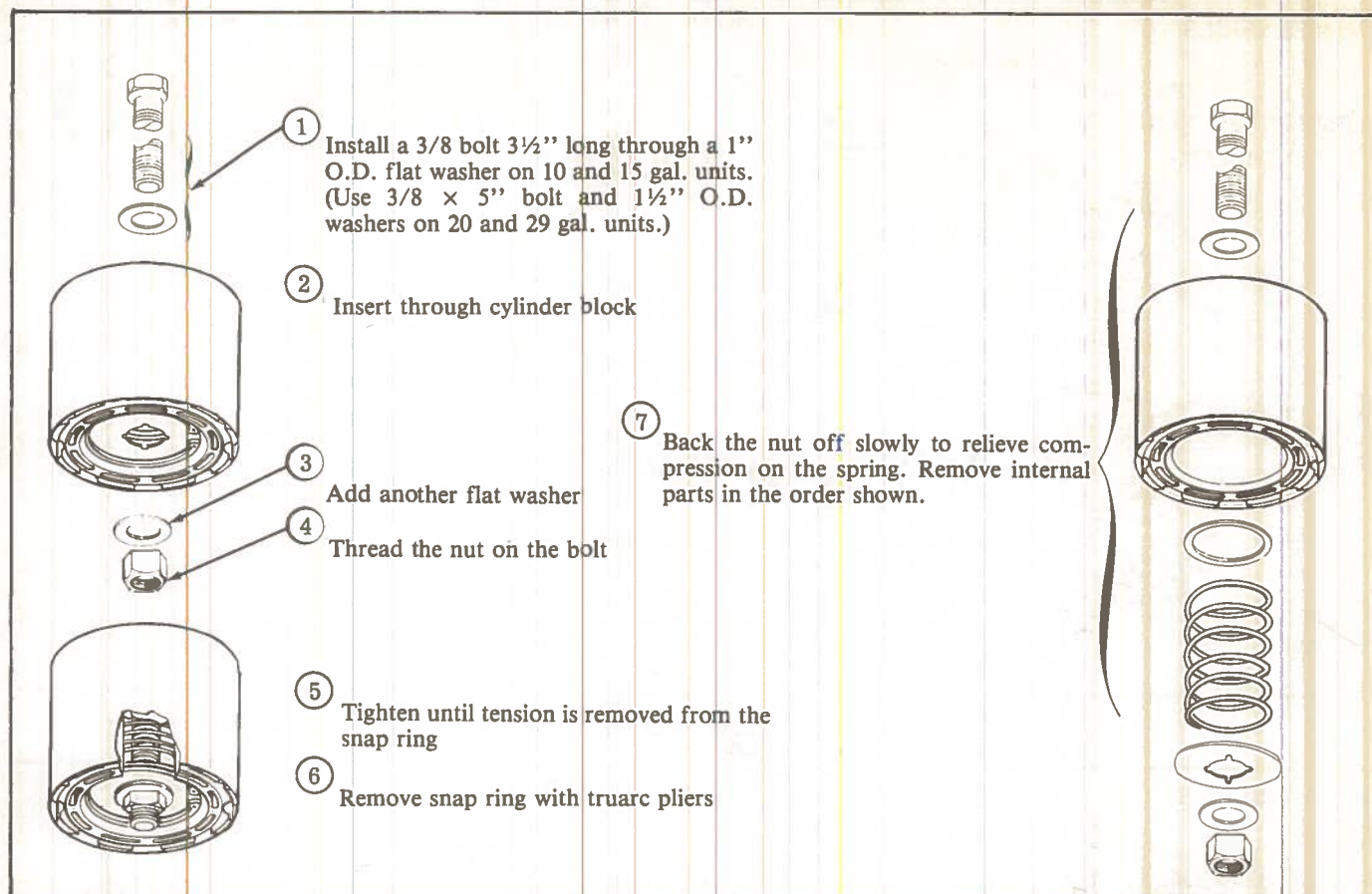


Figure 3. Cylinder Block Disassembly

a. Place the rotating group face down on a clean piece of Kraft paper.

b. Grasp shoe plate (20) and lift nine piston and shoe subassemblies (21) from cylinder block (16) with the shoe plate. Be careful not to strike the pistons together hard enough to create a burr or damage the pistons.

c. Remove spherical washer (19), backup washer (18) and pins (17). (Note: Some units do not use a backup washer.)

d. Observe caution during removal of spring (14) located within the cylinder block. The spring is under high compression and can cause bodily harm if retaining ring (12) is removed without adequate tooling. See Figure 3 for removal procedure.

8. Remove retaining ring (30) from housing (36) with truarc pliers.

9. Remove drive shaft (31), bearing (34), key (33), and retaining ring (37) from mounting flange of housing (36). Set aside for inspection.

10. Remove swash plate (22) from yoke subassembly (27). Rotate swash plate (22) and pull evenly from the yoke. Set aside for inspection.

11. Remove two screws (23) from yoke (27).

12. Remove pintles (24) with "O" rings (25) from yoke (27). Refer to Figures 4 and 5.

13. Remove yoke (27), refer to Figures 4 and 5, the yoke removal procedure for a variable displacement pump or motor.

14. Variable displacement units require removal of seat (28) and spring (29) from within housing (36).

15. Remove washer (32) and shaft seal (35) from the housing. Be careful during the removal of the shaft seal. DO NOT scratch the housing to seal mounting surface. Leakage can occur between the seal and housing if the aluminum housing is scratched.

C. INSPECTION, REPAIR AND REPLACEMENT

Prior to inspection, clean all parts thoroughly with a solvent that is compatible with system fluid. Replace all parts that do not meet the following specifications.

1. Valve Plate (7) - Lapping of the valve plate is not recommended. If wear or scoring is apparent, replace the valve plate. Check the shaft bearing located within the valve plate for roughness and pitting of the rollers. Replace if defective. Remove paint and/or burrs from outer edge of valve plate with an India stone.

2. Piston Rod (9), Spacer (10) and Piston (11) - Inspect compensator piston rod and piston for fit and/or wear. Spacer (10) is used on some models to limit maximum flow. Replace if defective.

3. Rotating Group Parts

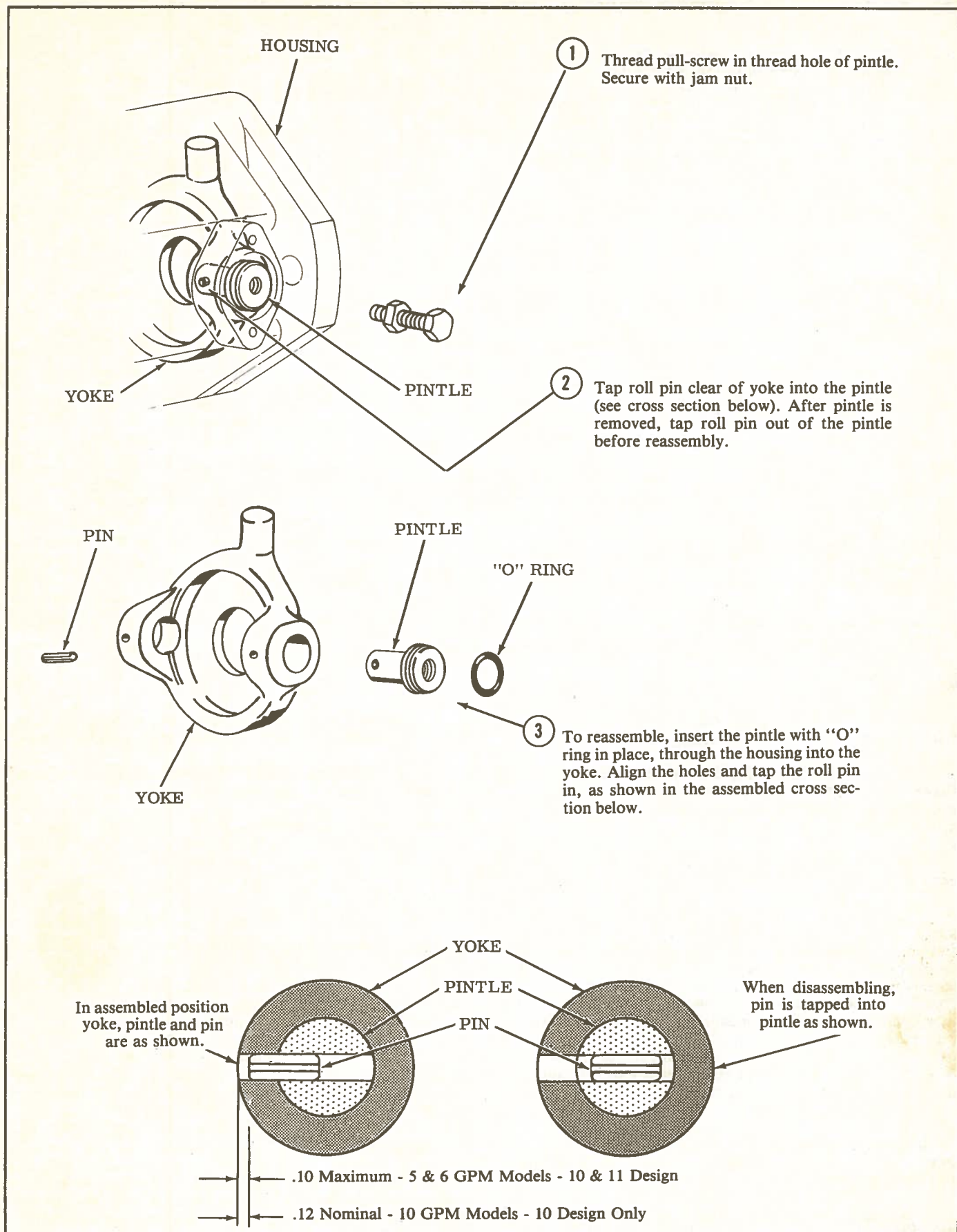
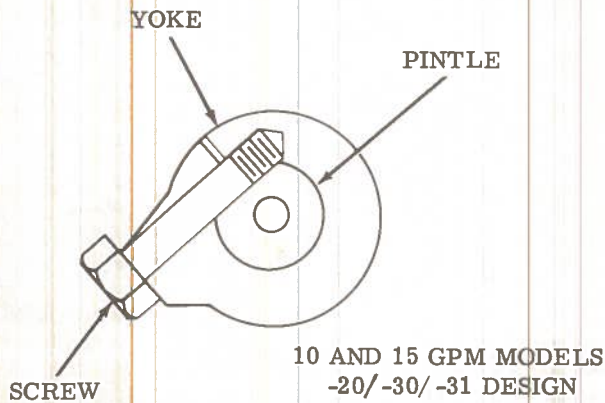
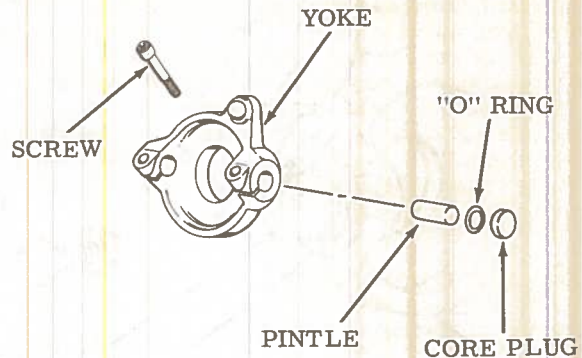


Figure 4. Removal of Pintle and Yoke, Smaller Models

The 10 and 15 GPM units of the -20/30/31 designs use a screw in lieu of the roll pin for securing pintles. The pintles are provided with a groove in place of the drilled hole to accept the screw (see cross section below).



- (1) Remove the core plug. Back-off lock screw at yoke until pindle groove clears for 20 and 29 GPM models. Lightly tap pindle toward inside of unit to remove. NOTE: Swash plate must be removed from yoke to remove these pintles.



- (2) To reassemble, insert the pindle through the housing into the yoke. Align the grooves and thread in lock screw.

20 AND 29 GPM MODELS

Figure 5. Removal of Pindle and Yoke, Larger Models

a. Inspect shoe plate (20) for wear or cracking in the area of spherical washer (19). If wear or cracks are found, replace the shoe plate and spherical washer at the same time.

b. Check spherical washer (19) for burrs and wear. Replace if defective.

c. Inspect pins (17) for equal length, wear and possible bending. Replace all pins simultaneously if one is defective.

d. Backup washer (18) does not exist in all models. Check for wear and replace if necessary.

e. Check each cylinder block (16) bore for excessive wear. Use the piston/shoe subassemblies (21) for this purpose. The piston should be a very close fit and slide easily in and out of the bore. No bind can be tolerated. If binding occurs, clean the cylinder block and piston, lubricate with clean hydraulic fluid and try again. Even minor contamination of the fluid can cause the piston to freeze up in the cylinder block bore.

f. Inspect each piston and shoe subassembly (21) for a maximum end play of 0.003 inch between the piston and shoe. The face thickness dimension, as shown in Figure 6, of each shoe must be within 0.001 inch of each other. A variation greater than 0.001 inch between all nine shoes indicates excessive wear. If one shoe needs replacement, replace all piston/shoe subassemblies. Replacement as a matter of procedure is recommended to obtain maximum overhaul life of the unit.

g. Inspect retaining ring (12), lift limiter washer (13), spring (14) and thrust washer (15) within cylinder block (16) for wear. Replace if necessary.

4. Inspect the face of swash plate (22) for wear, scratches and possible fracture. If the swash plate needs replacement, make sure the new swash plate rests flat against the face of yoke subassembly (27).

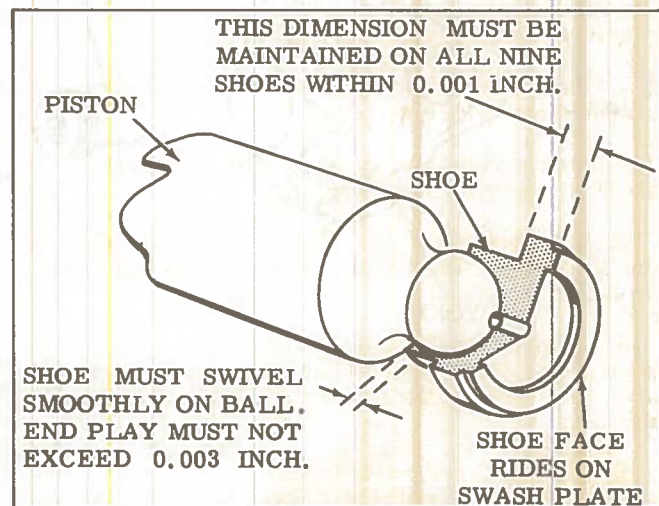


Figure 6. Piston and Shoe Assembly Tolerances

5. Inspect drive shaft (31) for wear, a chipped spline and burrs. Remove burrs with an India stone. Inspect the contact area of the shaft seal for wear and/or scoring. Replace the drive shaft if wear or scoring is greater than 0.005 T.I.R. (total indicator reading).

6. Inspect drive shaft bearing (34) for roughness in turning, pitting of the rollers and excessive end play. Replace if defective. If the bearing or shaft require replacement, removal of the bearing from the shaft is required. Use appropriate tooling to hold the inner race of the bearing and press the shaft from the bearing. Assemble new parts together in a similar manner, always applying force to the shaft and inner race of the bearing. DO NOT apply force to the outside bearing race. Install retaining ring (37).

7. Inspect yoke subassembly (27) face for wear, roughness or scoring. Check pintle bores of yoke for wear. Replace if defective.

8. Inspect pintles (24) and pintle bearings (26) for wear. Replace if defective. If a pintle bearing requires replacement, use a tool smaller than the housing bore and drive the pintle bearing into the housing and remove. Be careful not to score the housing bore during removal. Clean up the bore and lubricate both the bore and new pintle bearing with system fluid. Be very cautious during installation of new pintle bearings. If a bearing is misaligned with the bore at start of press, the bearing cage will warp and a bind will occur. Use an arbor press to install new pintle bearings. DO NOT press a bearing past the inside lip of the housing or interference with the yoke will result.

9. Inspect housing (36) mounting flange for nicks and burrs. Remove with an India stone. Remove paint and/or burrs from outer edge of housing.

D. ASSEMBLY

Assembly is performed in the reverse order of disassembly. Special procedures are noted in the following text.

A new seal kit should be obtained. Refer to the parts drawing for your model (see Table 1). Replace all seals, gaskets and "O" rings with new ones from the kit. A light film of clean hydraulic fluid will provide ease of assembly and initial lubrication of moving parts. Assemble as follows:

1. Install new shaft seal (35) into housing (36) with spring loaded member facing into the housing.

2. Install spring (29) over spring guide in housing. Insert seat (28) into spring.

3. Install yoke (27) in housing (36) as illustrated in Figures 4 and 5. Make sure seat (28) is in position and engages within the yoke.

4. Install pintles (24) and "O" rings (25) as illustrated in Figures 4 and 5. Install screws (23) and torque to recommended values. Refer to parts drawing for applicable unit found in Table 1.

5. Place shaft seal retainer (32) over shaft seal. Install drive shaft (31) and retaining ring (30) up against bearing into housing groove.

6. Lubricate and install swash plate (22) with chamfer side facing yoke (27). It is important that the swash plate be properly seated within the yoke and can be freely moved (rotated) with the fingers.

7. If the cylinder block was disassembled, refer to Figure 3 for assembly. Place the cylinder block face down on a clean piece of Kraft paper and insert three pins (17) into the cylinder block. Lubricate back-up washer (18) (not used on some models) and spherical washer (19), place them over pins (17). Lubricate the cylinder block bores and pistons with system fluid. Install the nine pistons (21) through shoe plate (20) and into the cylinder block bores. The pistons must move freely within the bores. The rotating group is now assembled and ready for installation into the pump or motor housing. Hold cylinder block (16) and shoe plate (20) together to keep pins (17) and washer(s) (18 & 19) intact, then install rotating group over the drive shaft. A slight rotation of the drive shaft during assembly will help align spherical washer (19) and cylinder block (16) splines with those of the shaft.

8. Lubricate the face of the valve plate. Make sure paint and burrs have been removed from the outer edge of housing (36) and valve plate (7). Install gasket (8) on housing (36).

9. Install piston rod (9) into valve plate. Slide retaining ring (5) over piston rod (9) and into retaining ring groove. Install spacer (10) (used only on models with reduced flow capability), and piston (11) over piston rod (9).

10. Align drive shaft to bearing and install valve plate (7) on housing (36). Thread retaining screws (6) through valve plate and into housing. Torque to the values noted in parts drawing for the unit.

11. Lubricate and install "O" ring (4) in "O" ring groove of piston rod (9). Install gasket (3) on valve plate (7). CAUTION: Position gasket as shown in Figure 2 with teardrop hole pointing toward compensator adjusting screw.

12. Place compensator body (2) over gasket (3) on valve plate (7). Make sure body of compensator and gasket are installed in the correct position for shaft rotation (see Figure 2). Thread retaining screws (1) through compensator into valve plate. Torque screws to the values noted on parts drawings for the unit.

13. Install drive shaft key (33) into drive shaft (31). Make sure key is seated properly.

E. CONVERSIONS

When changing the direction of rotation of an inline hydraulic pump, it will become necessary to change to the respective valve plate for that rotation. If the pump happens to be a compensated type, the compensator must be rotated 180° and the compensator gasket must follow. Consult the appropriate parts drawing listed in Table 1 for the proper valve plate selection.

Hydraulic motors with "V" in the model code require only the rotation of the compensator to change direction. When a change such as this is made, it should be noted by a change in the name plate and any directional arrows as an aid in future identification.

Litho in U.S.A.

Service Parts Information

MULTI-TORQUE VANE MOTORS

MHT-190, 220 & 250

VICKERS
A TRIMMOVA COMPANY

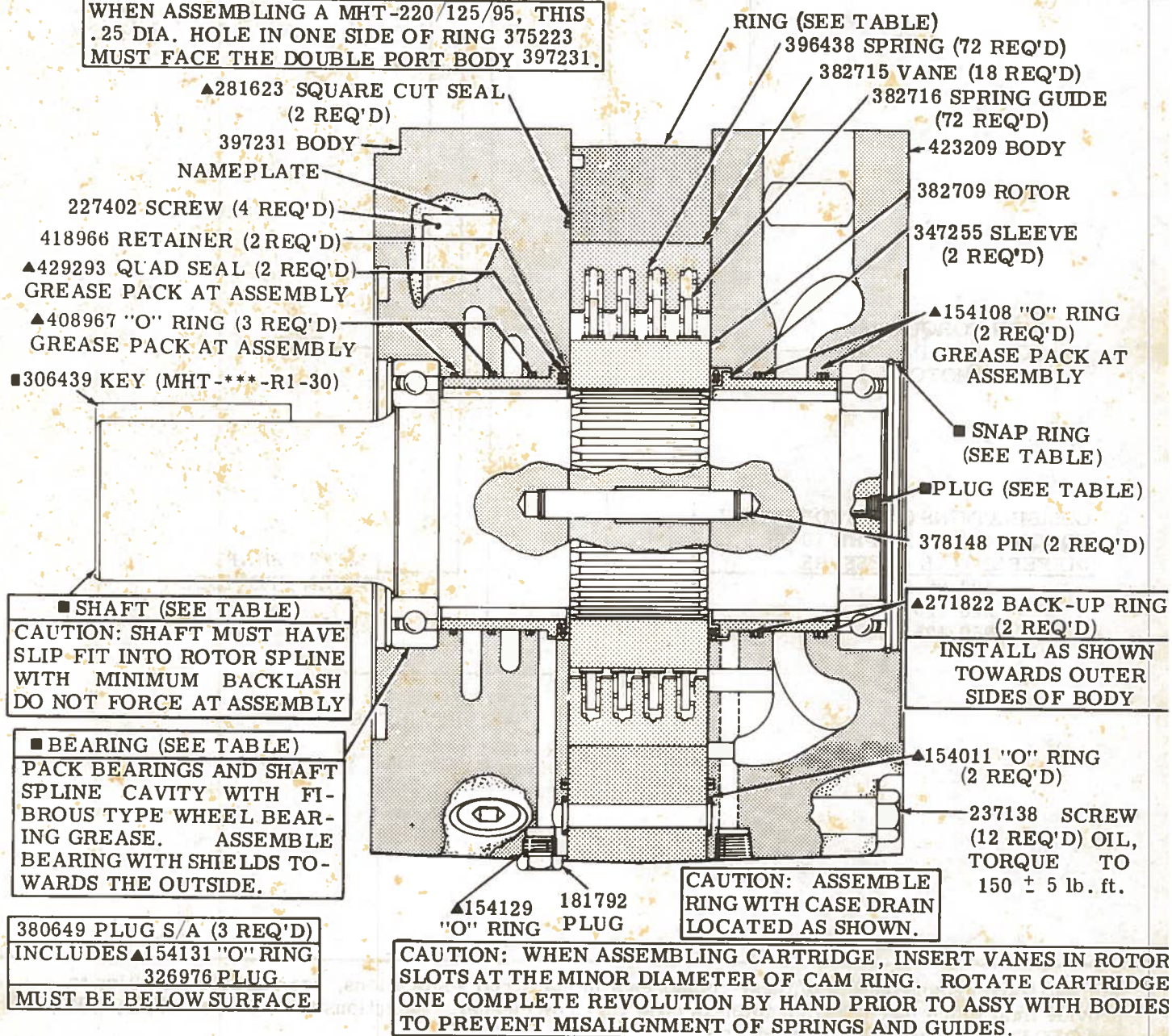
MODEL	SHAFT	SNAP RING (2 REQ'D)	RING	BEARING (2 REQ'D)	PLUG
MHT-190/95/95-*1-30	345769	354386	364468	310539	7074
MHT-220/125/95-*1-30			375223		
MHT-250/125/125-*1-30			343826		

F3 SEAL KIT
919880

■ **OMIT ON**
N1 MODELS

▲ **INCLUDED IN**
919769 SEAL KIT

WHEN ASSEMBLING A MHT-220/125/95, THIS
.25 DIA. HOLE IN ONE SIDE OF RING 375223
MUST FACE THE DOUBLE PORT BODY 397231.



MODEL CODE BREAKDOWN

MHT-*/**(*)/**(*)-(*)1-30**

HIGH TORQUE
LOW SPEED
VANE MOTORS

DESIGN

COMBINATIONS OF THEORETICAL
TORQUE IN lbf. ft. PER 100 P.S.I.
DIFFERENTIAL PRESSURE.

190/95/95
220/125/95
250/125/125

KEYED SHAFT
WHEN PROVIDED

N - NO SHAFT
AND BEARINGS
R - SOLID SHAFT

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Service Parts Information

**HIGH TORQUE
LOW SPEED
VANE MOTORS**

MHT 380/440/500

VICKERS®
A TRIMONA COMPANY

MODEL	SHAFT	SNAP RING	KEY	BEARING	PLUG	RING
MHT-380-*1-30						364468
MHT-440-*1-30	377512	354386	332265	310539	7074	375223
MHT-500-*1-30						343826

*OMIT FOR
N1 MODELS

227402 SCREW
(4 REQ'D)

NAMEPLATE

▲154108 "O" RING
(4 REQ'D)
PACK WITH GREASE
AT ASSEMBLY.

*SHAFT (SEE TABLE)

SHAFT MUST HAVE SLIP FIT
INTO ROTOR SPLINE WITH
MINIMUM BACKLASH. DO
NOT FORCE AT ASSEMBLY.

*KEY (SEE TABLE)

STD/F3 SEAL KIT
CROSSREFERENCE

▲STD	F3
919885	919886

*BEARING (SEE TABLE)
(2 REQ'D)

NOTE: PACK BEARINGS AND
SHAFT SPLINE CAVITY WITH
FIBROUS TYPE WHEEL BEAR-
ING GREASE. INSTALL BEAR-
INGS WITH SHIELDS ON OUT-
SIDE.

▲271822 BACK-UP RING (4 REQ'D)
GREASE PACK AT ASSEMBLY.
INSTALL AS SHOWN TOWARDS
OUTER SIDES OF BOTH BODIES.

▲154130 181792
"O" RING PLUG

▲154011 "O" RING
(4 REQ'D)

▲154128 "O" RING

181728
DRAIN PLUG

281623 SQUARE CUT
SEAL (4 REQ'D)

RING (SEE TABLE)
(2 REQ'D)

397480 SPACER
ASSEMBLE BOTH RINGS
AND SPACER WITH CASE
DRAIN HOLE AS SHOWN.
NOT ROTATED WITH
HOLE AT TOP.

CAUTION: WHEN ASSEMBLING CARTRIDGE, INSERT VANES IN ROTOR
SLOTS AT THE MINOR DIAMETER OF CAM RING. ROTATE CARTRIDGE
ONE COMPLETE REVOLUTION PRIOR TO ASSEMBLY WITH BODIES. THIS
PREVENTS MISALIGNMENT OF SPRINGS AND GUIDES.

418966 RETAINER (4 REQ'D)
382715 VANE (36 REQ'D)
396438 SPRING (144 REQ'D)
382716 SPRING GUIDE (144 REQ'D)
382709 ROTOR (2 REQ'D)

▲429293 QUAD SE
(4 REQ'D)
PACK WITH GREASE
AT ASSEMBLY

*SNAP RING
(2 REQ'D)
(SEE TABLE)

378149 PIN
(2 REQ'D)

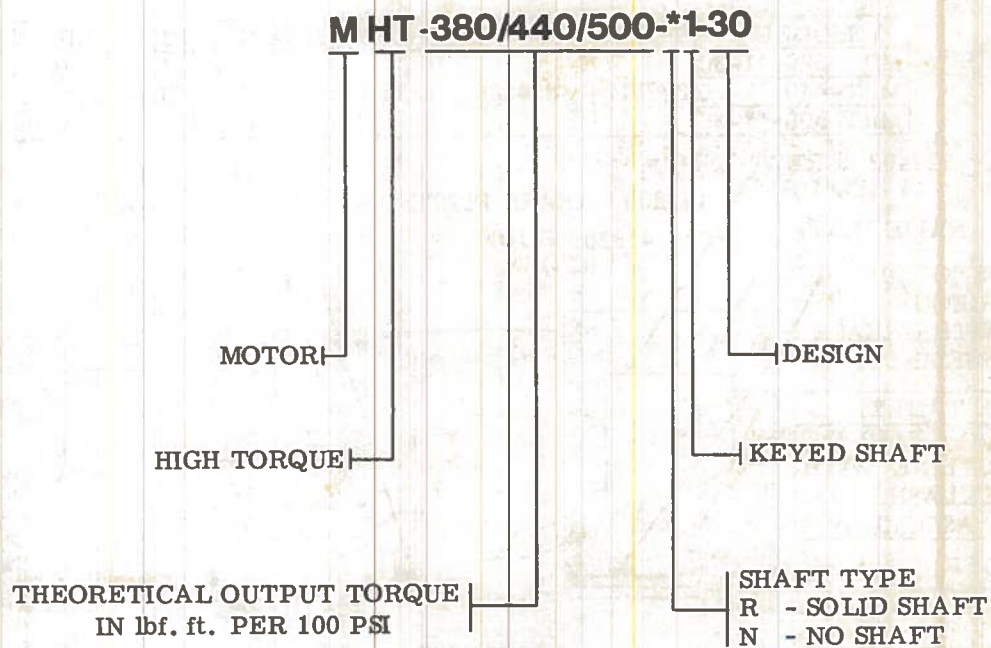
*PLUG
(SEE TABLE)

347255 SLEEVE
(2 REQ'D)

332267 SCREW
(12 REQ'D)
TORQUE TO
150 ± 5 lbf. ft.
OILED

DRAIN

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Service Parts Information

**HIGH TORQUE
LOW SPEED
VANE MOTORS**

MHT 110/130/150

VICKERS
A TRIMMOVA COMPANY

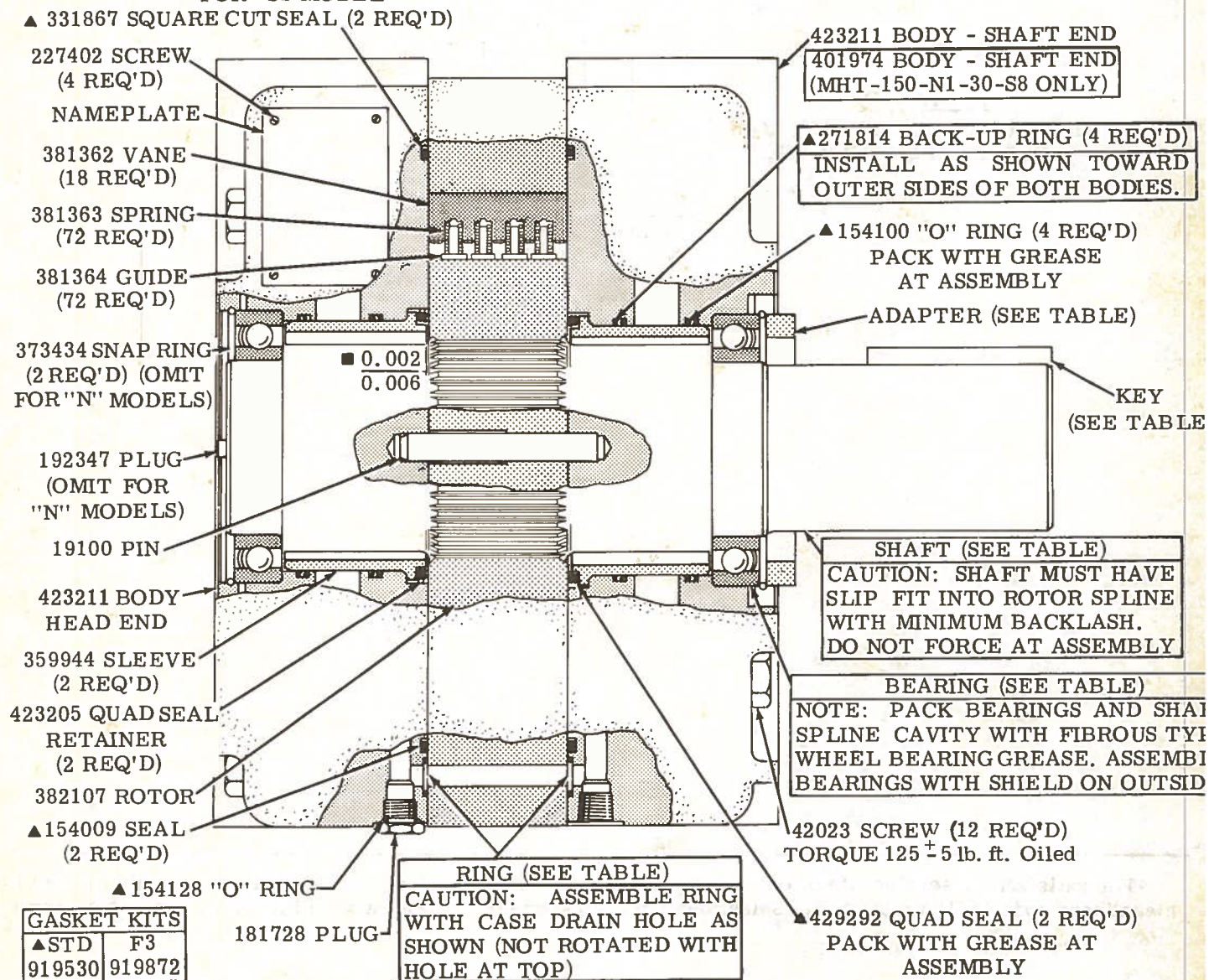
Caution: To assemble cartridge, insert vanes in rotor slots at minor diameter of cam ring. Rotate cartridge (1) complete revolution prior to ass'y with bodies to prevent misalignment of springs & guide

■ **INSTALL SLEEVES
BELOW FACE OF
BODY 0.002 INCH
0.006**



**BEARING ASSEMBLY
FOR -S1 MODEL**

MODEL	SHAFT	KEY (*2 REQ'D)	BEARING (*2 REQ'D)	RING	ADAPTER (*2 REQ'D)
MHT-110-N1-30	—	—	—	401623	—
MHT-110-R1-30	356165	334231	(*) 373927	—	—
MHT-130-N1-30	—	—	—	375221	—
MHT-130-R1-30	356165	334231	(*) 373927	—	—
MHT-150-N1-30	—	—	—	—	—
MHT-150-N1-30-S1	—	—	334582	—	—
MHT-150-R1-30	356165	334231	(*) 373927	356176	374542
MHT-150-R1-30-S3	354379	(*) 334231	(*) 373927	—	(*) 374542
MHT-150-N1-30-S8	—	—	—	—	—



MODEL CODE BREAKDOWN

MHT-1*0-1-30-(S*)

HIGH TORQUE
LOW SPEED
VANE MOTOR

SPECIAL

DESIGN

110-130-150
THEORETICAL OUTPUT TORQUE
IN lbf. ft. PER 100 P.S.I.

SHAFT TYPE
N1 - NO SHAFT
R1 - SOLID SHAFT
WITH SQUARE
KEY

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Service Parts Information

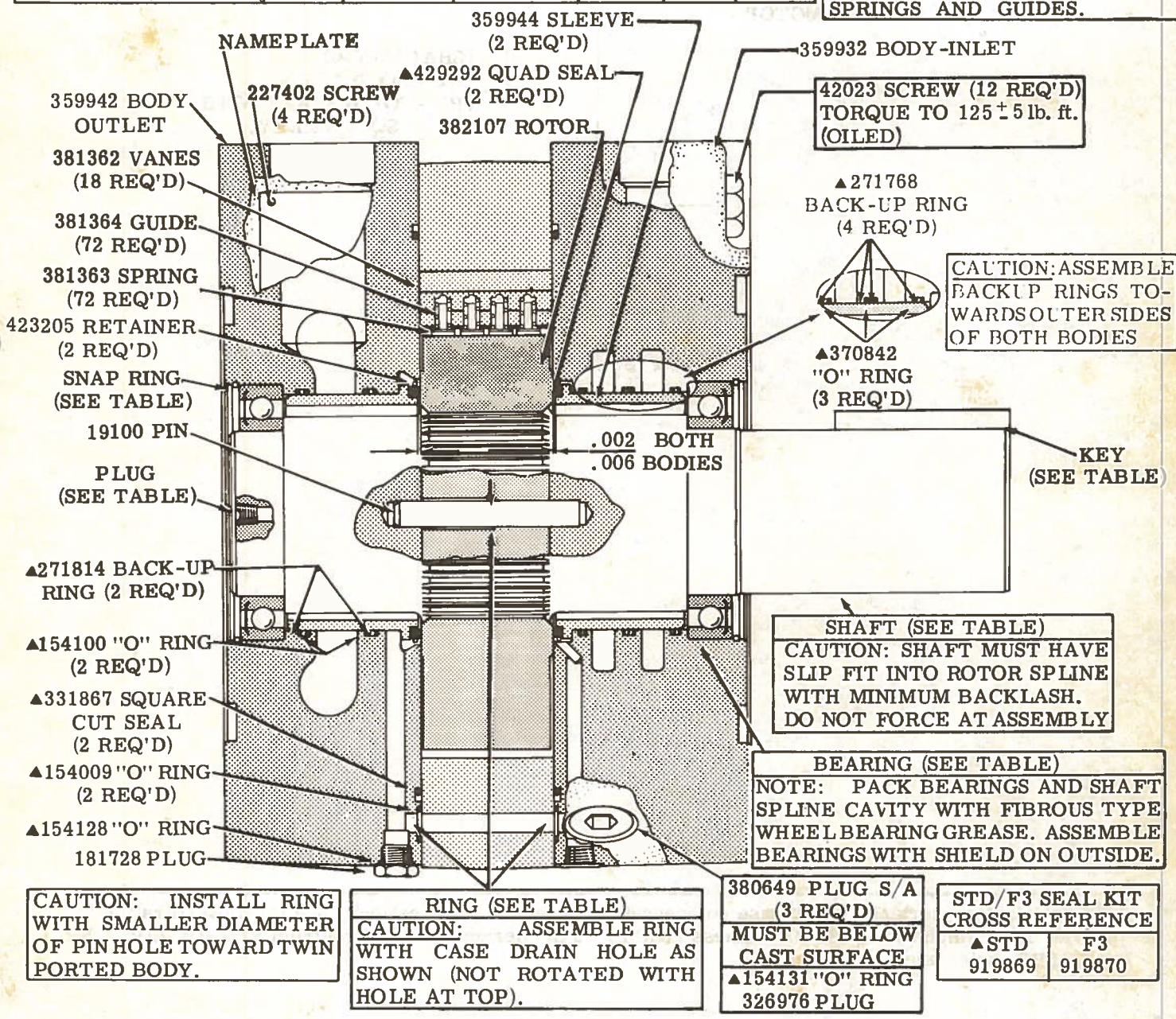
MULTI-TORQUE VANE MOTORS

MHT 110/130/150 - 30 DESIGN

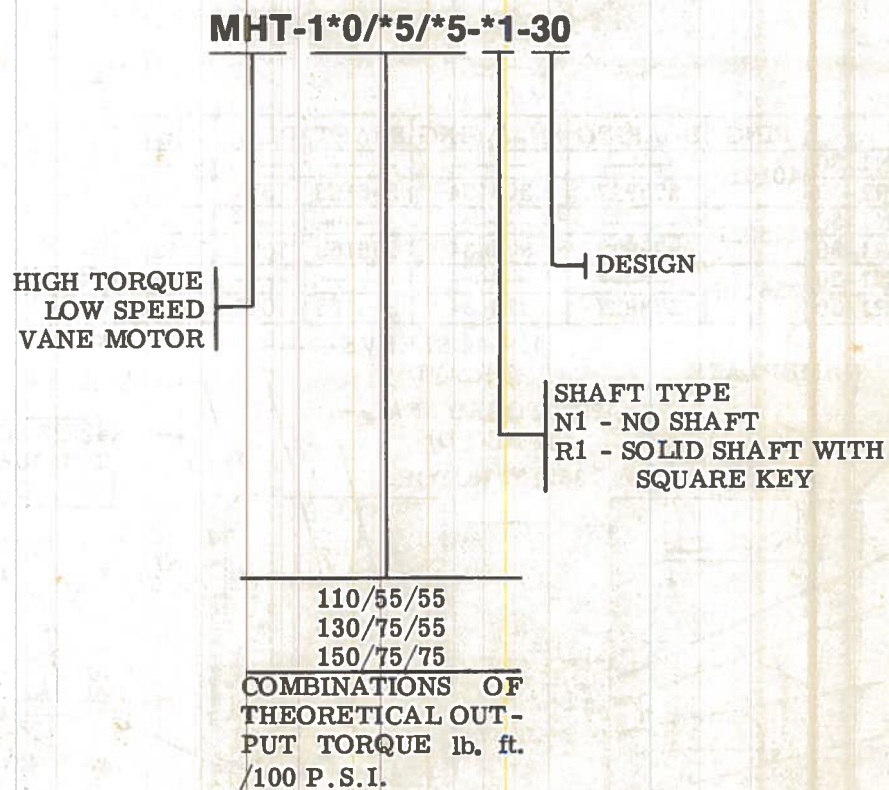


MODEL	RING	BEARING	SNAP RING	SHAFT	PLUG	KEY
MHT-110/55/55-N1-30	401623					
MHT-110/55/55-R1-30		373927	373434	356165	7074	334231
MHT-130/75/55-N1-30	375221					
MHT-130/75/55-R1-30		373927	373434	356165	7074	334231
MHT-150/75/75-N1-30	356176					
MHT-150/75/75-R1-30		373927	373434	356165	7074	334231

CAUTION
WHEN ASSEMBLING CARTRIDGE INSERT VANES IN ROTOR SLOTS AT THE MINOR DIAMETER OF CAMRING. ROTATE CARTRIDGE ONE COMPLETE REVOLUTION PRIOR TO ASSY. WITH BODIES TO PREVENT MISALIGNMENT OF SPRINGS AND GUIDES.



MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

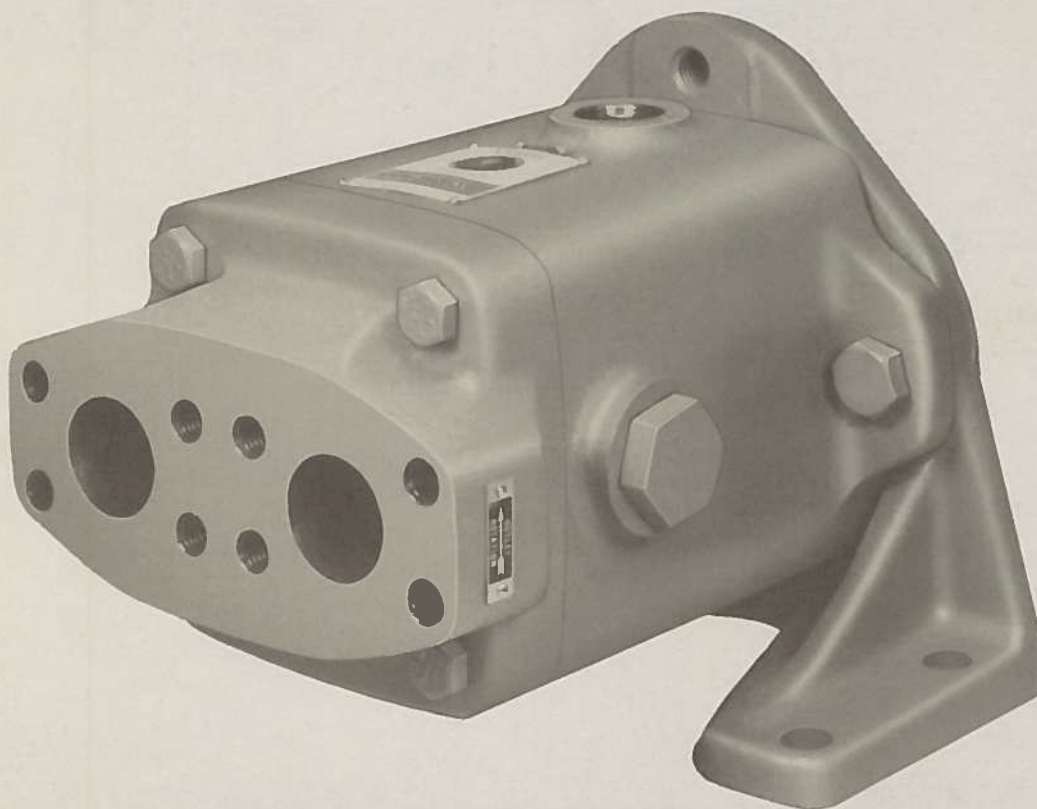
Litho in U. S. A.

VICKERS®
A TRIHIOVA COMPANY

Service Parts Information

**29 GPM
Fixed
Displacement
Inline Piston
Motors**

MFB29-(F)UF-20



Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

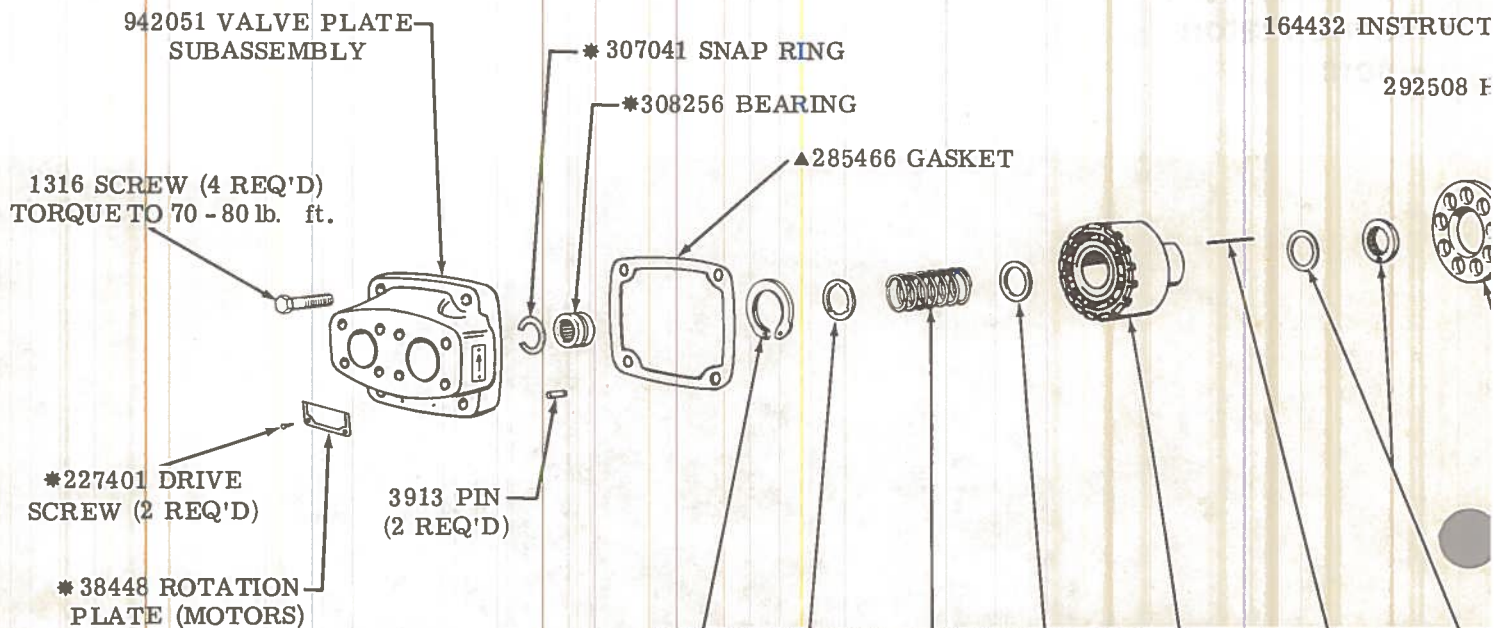
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I-3741-S

2274

164432 INSTRUCT

292508 F

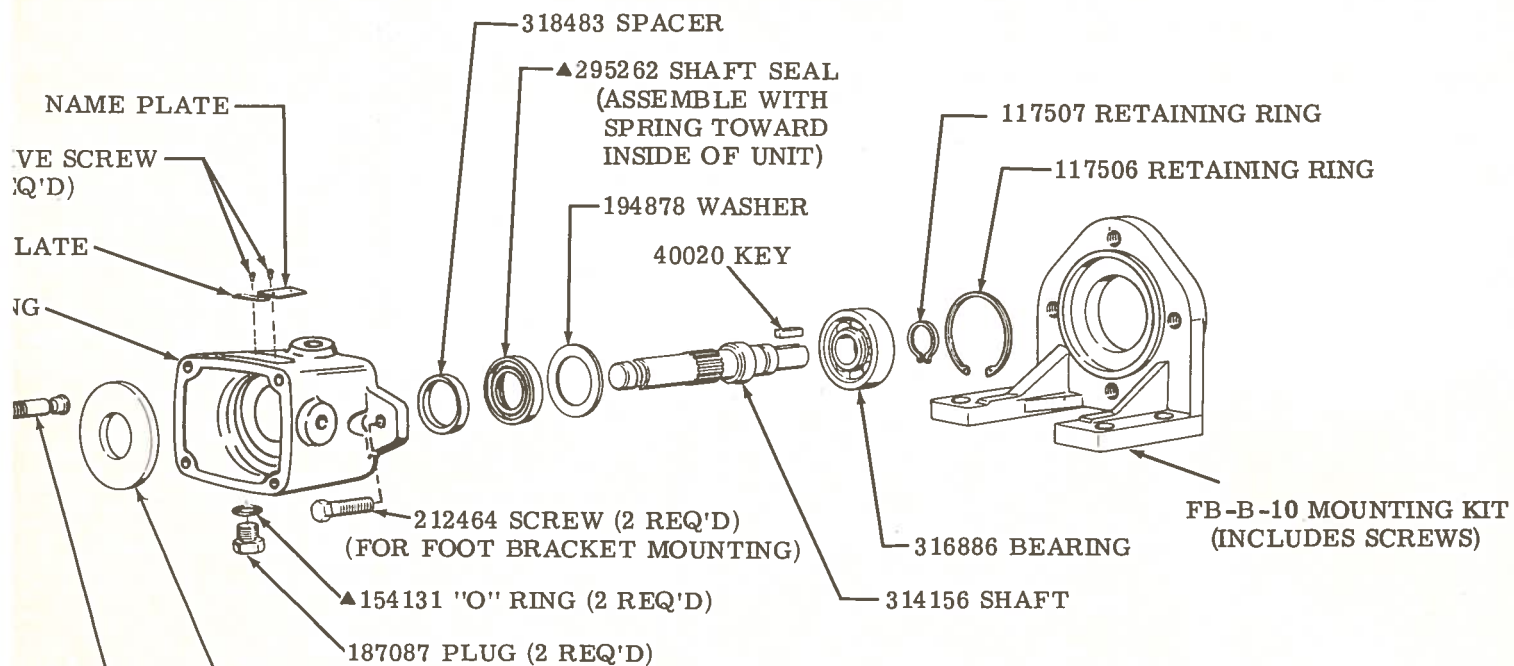


RET. RING	LIFT LIMITER	SPRING	THRUST WASHER	CYLINDER BLOCK	PIN (3 REQ'D)	WASHER SUBAS
THESE PARTS ARE						
194025	244931	246387	238780	287454	248835	93839

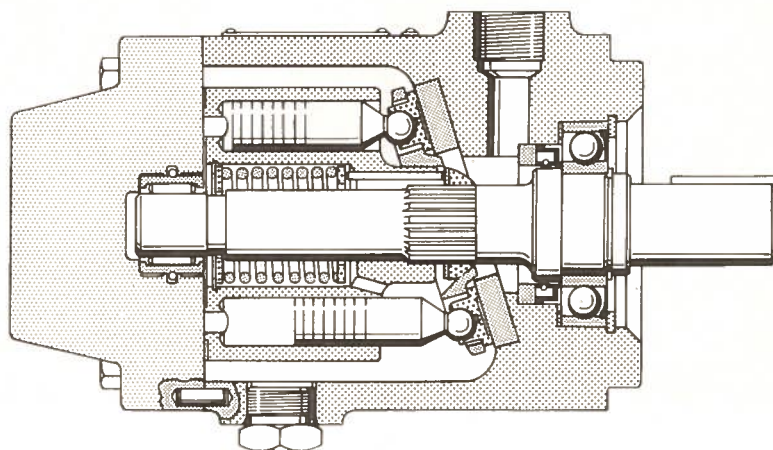
*INCLUDED IN
VALVE PLATE
SUBASSEMBLY

INCLUDED IN
919242 SEAL KIT

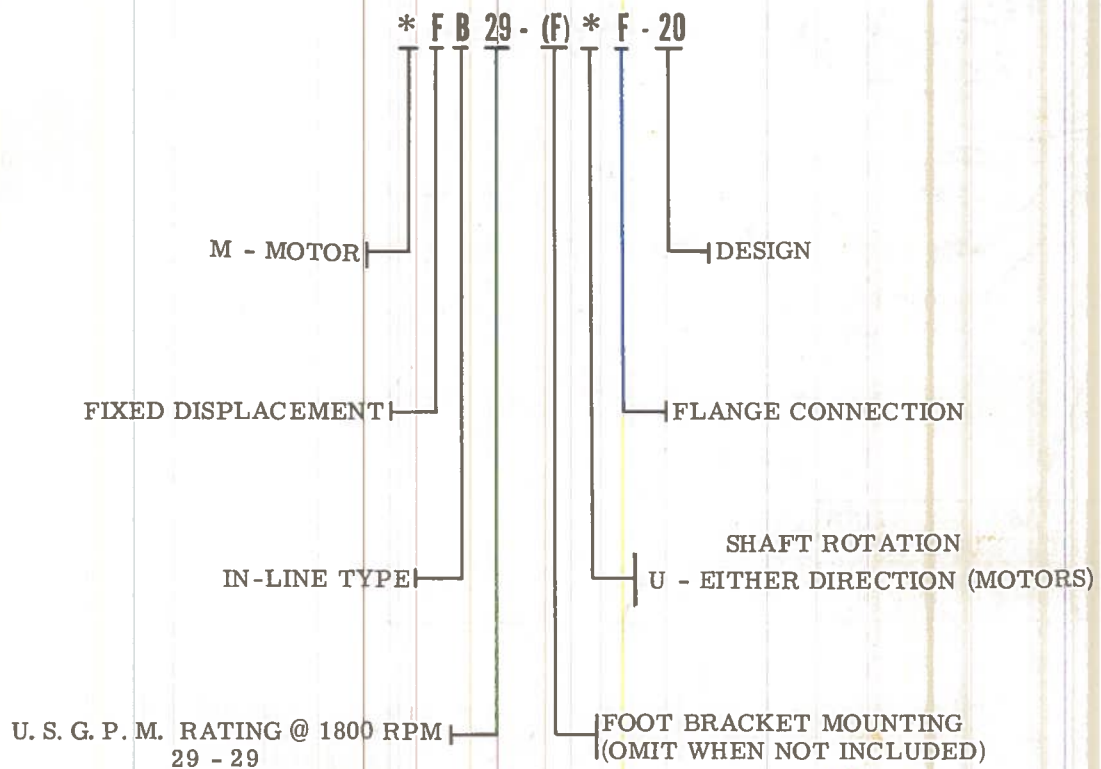
F3 EQUIVALENT
919313 SEAL KIT



IOE	PISTONS/A	SWASH	ROTATING
ATE	KIT	PLATE	GROUP KIT
DED IN			
3609	941885	239335	938295



MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

Litho in U. S. A.

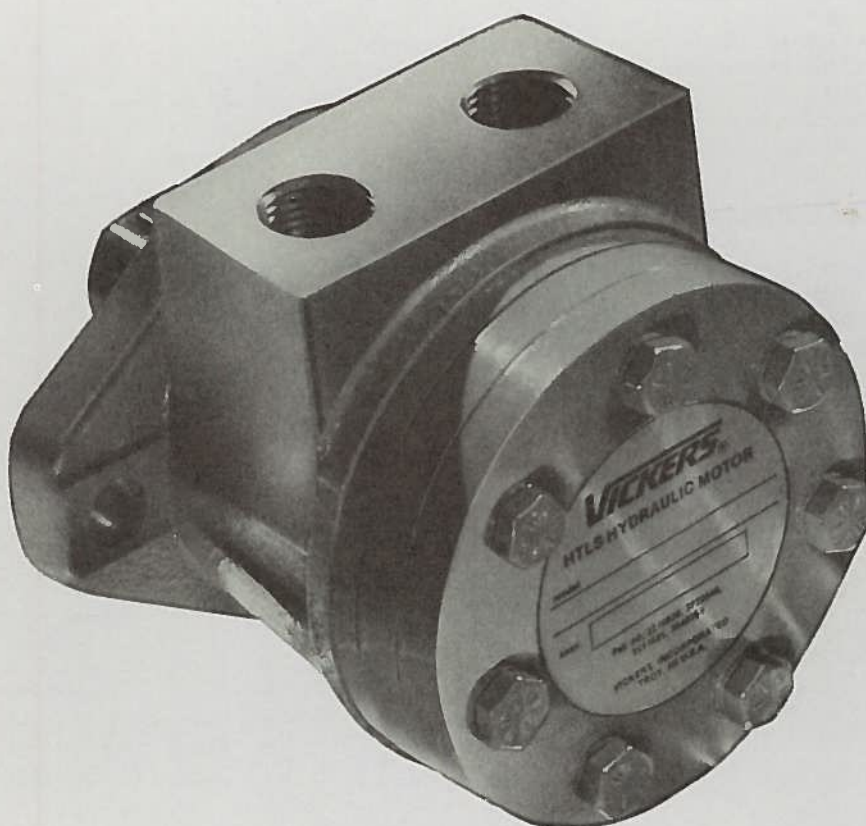


A TRIMINOVA COMPANY

Overhaul Manual

**Orbital
High Torque
Low Speed
Motors
(HTLS)**

HMA-1000 Series
HMA-2000 Series



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

Revised 9-1-86

M-2750-S

SECTION

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Section I - INTRODUCTION

A. PURPOSE

This manual describes basic operational characteristics and provides service and overhaul information for the Vickers HMA-1000/2000 Series Orbital, High Torque Low Speed Hydraulic Motors. The information contained herein pertains to the latest design series.

B. GENERAL INFORMATION

1. Related Publications - Installation dimensions are not contained in this manual. The installation drawing listed in Table 1 is available from any Vickers application engineering office or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

MODEL	INSTALLATION DRAWING
HMA-1000/2000 Series	359

Table 1. Installation Drawing.

Section II - DESCRIPTION

A. GENERAL

Assembly of a typical orbital, High Torque Low Speed (HTLS) motor is shown in Figure 1. Reference to each of the motor's basic components are shown.

B. APPLICATION

Motor displacements are shown in the model code Table 2. For torque ratings, speeds, methods of installation and other application information, refer to the installation data (Table 1) or contact Vickers application engineering personnel.

MODEL CODE BREAKDOWN

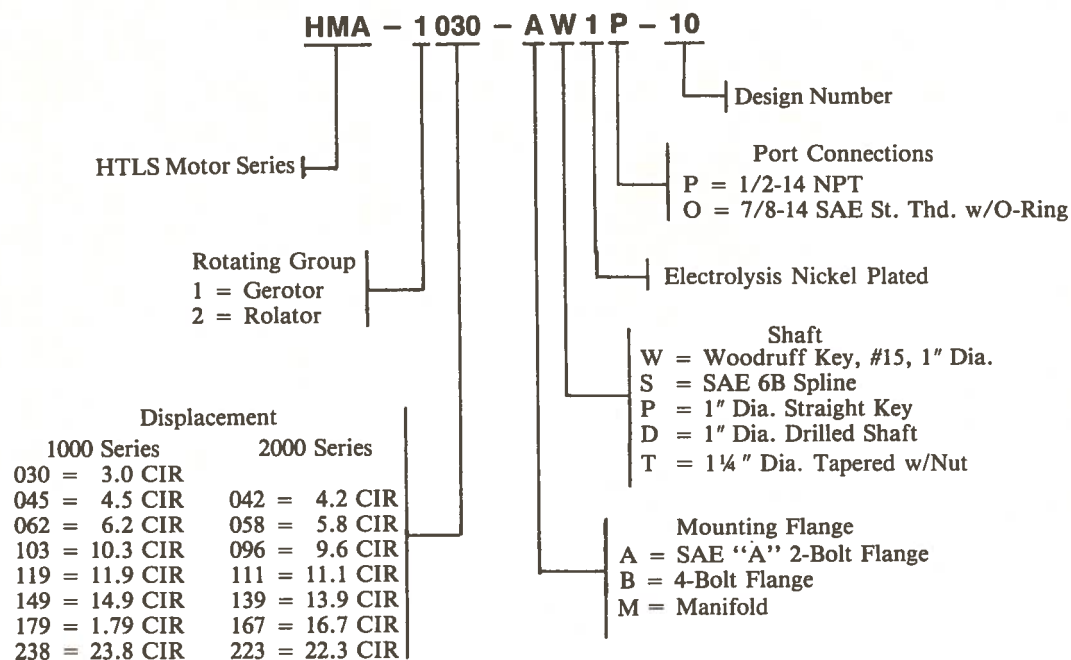


Table 2. Model Code Breakdown.

Section III - PRINCIPLES OF OPERATION

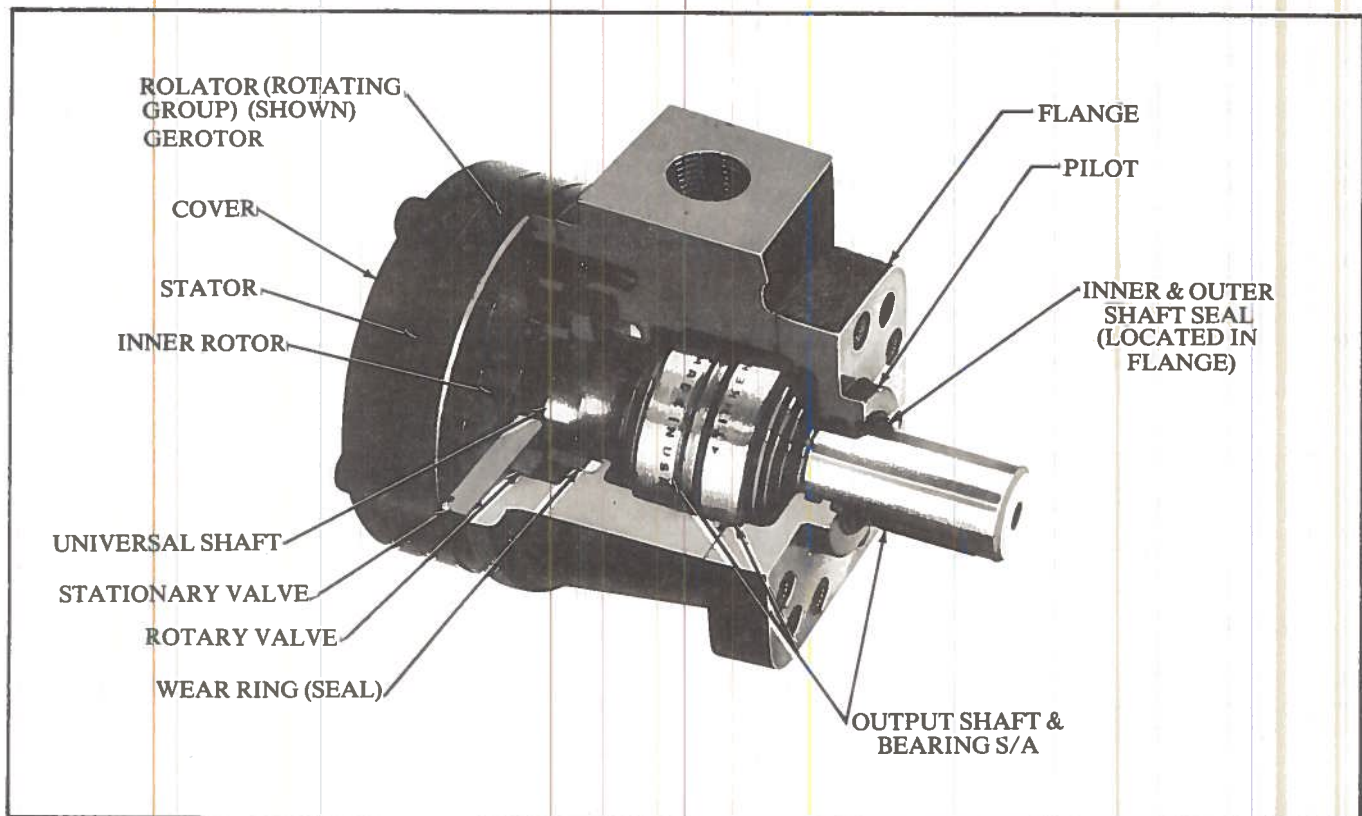


Figure 1. Cutaway View of (Rotary Type) HTLS Motor.

A. BASIC PARTS

An orbital High Torque Low Speed (HTLS) Motor is comprised of five basic operating parts: an inner rotor, an outer stator (rotating group), a small universal shaft which couples the orbital rotating motion of the inner rotor to the output shaft and bearing S/A, a rotary valve assembly and wear ring

seal.

Two types of rotating group assemblies exist: the gerotor type and the rolator type (see Figure 2). These units are directly interchangeable on a given unit. The rolator is more efficient than the gerotor due to the rolling action of the rollers under a pressure situation.

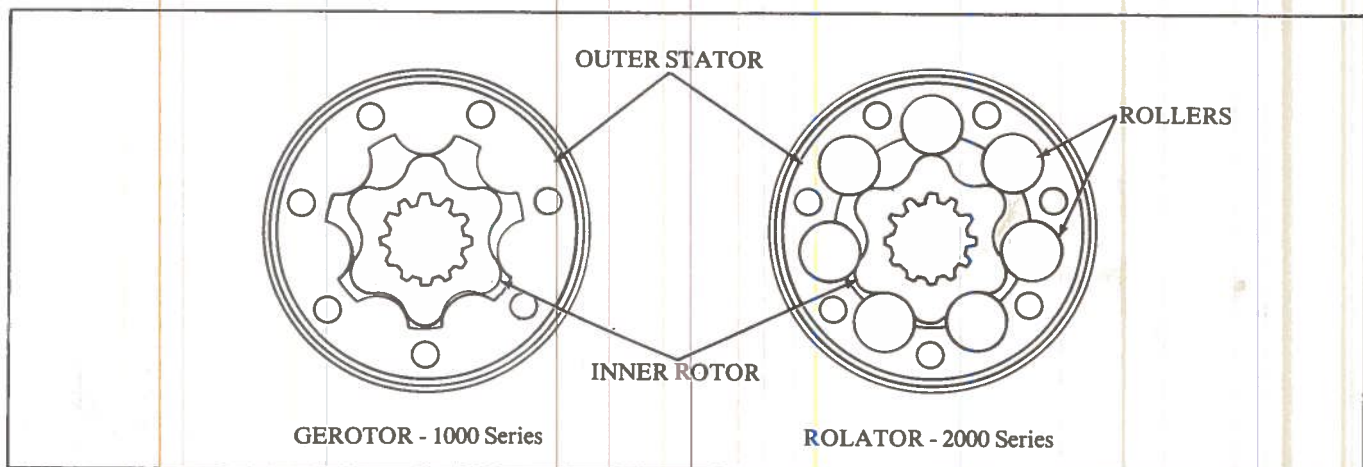


Figure 2. Rotating Group Configurations.

B. MOTOR OPERATION

NOTE

During the following discussion of unit operation, refer to Figure 3. The large arrow shown in both views indicates the effective centerline of the rotating valves' position which determines the pressure (P) and tank (T) quadrants.

The pressure in Figure 3(a) will move the bottom of the inner rotor toward the right side of the page, rotating the inner rotor counterclockwise. This causes the inner rotor to orbit in a clockwise direction through each lobe position (a through g). Figure 3(b) shows the second lobe position (b) and the new pressure and tank quadrant position. As you can see, pressure will force the inner rotor toward the (c) lobe position when the rotor lobe is located in the (b) position. The inner rotor must go through six clockwise orbits for one counterclockwise rotation of the output shaft.

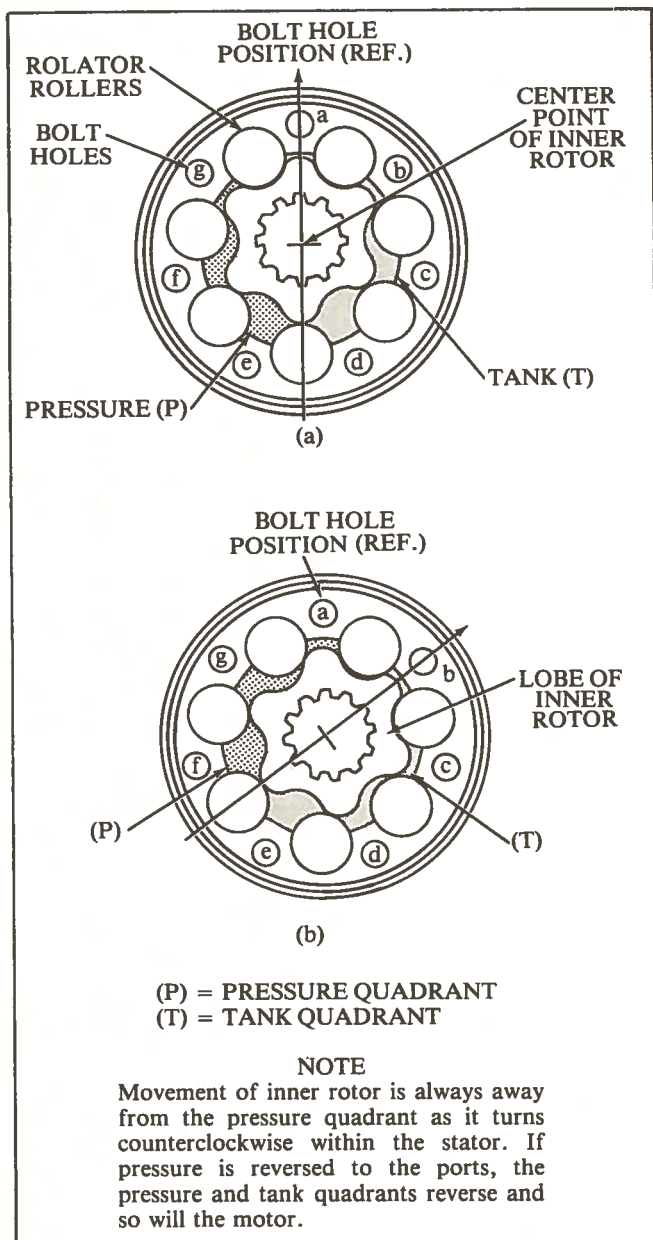


Figure 3. Gerotor/Rolator Operation.

C. ROTARY VALVE ASSEMBLY

A rotary valve (Figure 4) is coupled to the drive shaft with a tang and opens pressure and return through a stationary valve (Figure 5) to the appropriate set of chambers formed by the lobes of the inner rotor and stator (the rotating group).

The rotary valve assembly, the inner rotor and the output shaft are all coupled together by the universal shaft. Therefore, pressure and tank openings in the rotary valve assembly are always in time with the rotating group (gerotor/rolator) section of the motor.

Summarizing: the pressure and tank quadrants effectively move in a clockwise direction as the inner rotor and rotary valve turn counterclockwise. This causes the inner rotor to orbit in a clockwise direction within the stator.

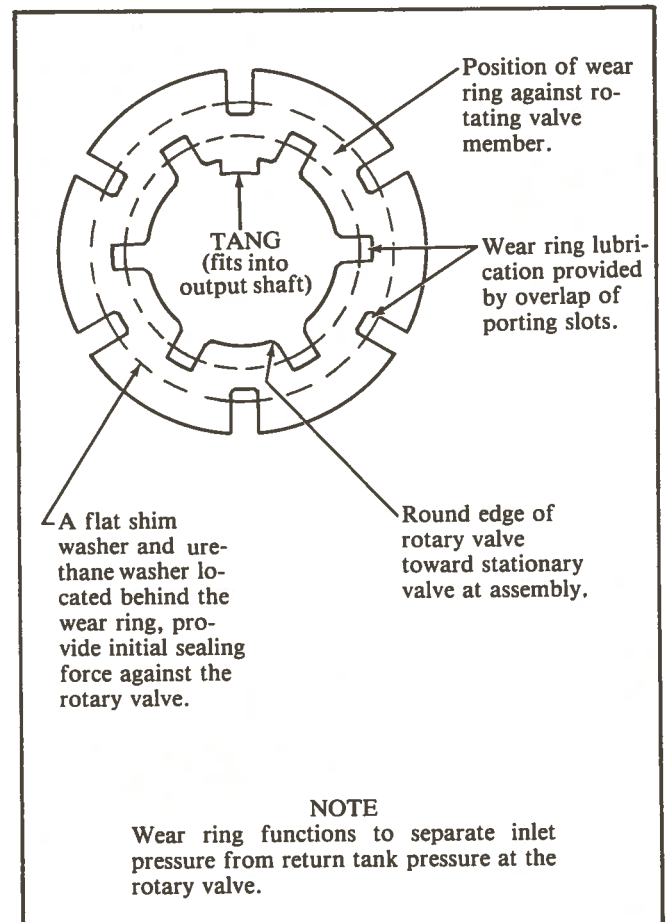


Figure 4. Rotary Valve Section.

D. WEAR RING, ROTARY SEAL

The rotary valve pressure and tank openings are effectively separated and sealed by a wear ring which rests against the back of the rotary valve. A urethane washer and shim washer provide the initial force to hold the wear ring against the rotating portion of the valve. Inlet pressure against the rotary valve provides additional force during the run cycle. The rotary valve porting slots overlap the thickness of the wear ring approximately half way. This provides lubrication of the mating surfaces during operation (see Figure 4).

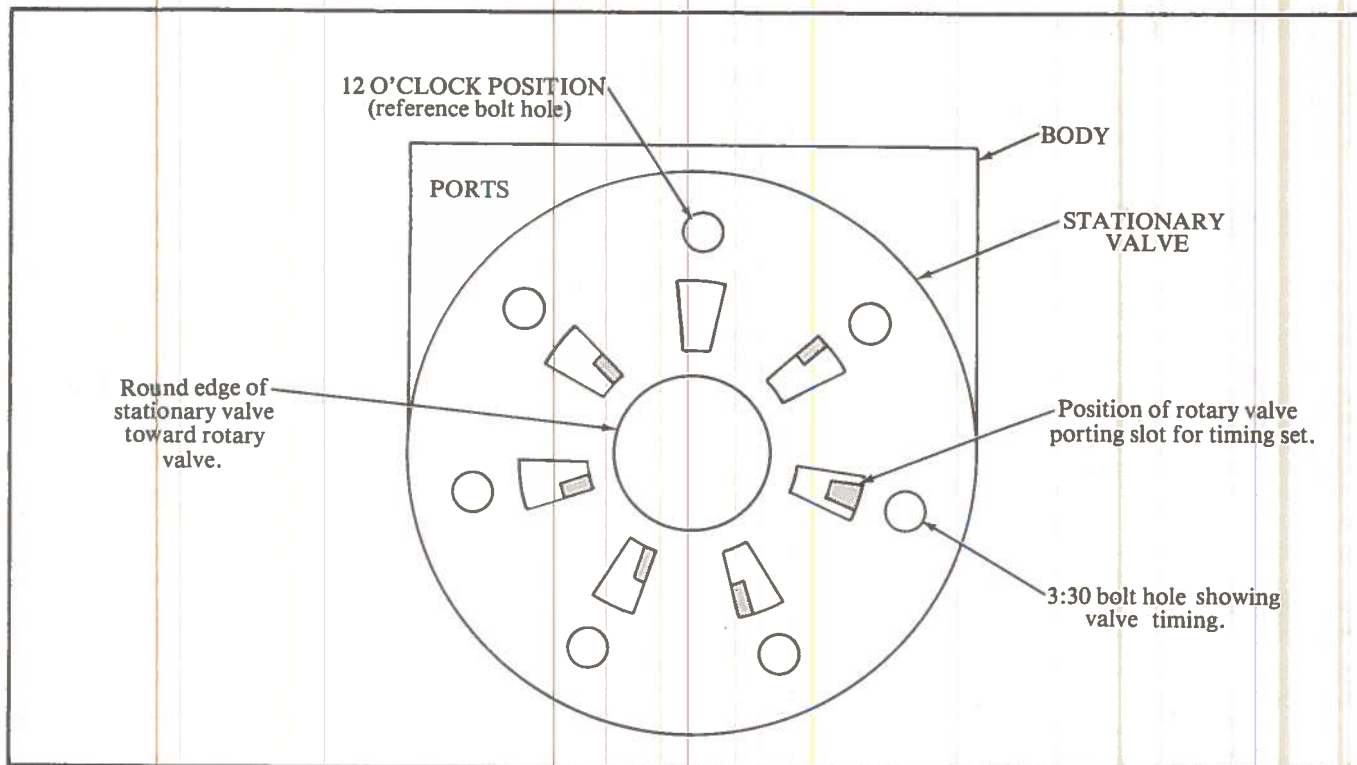


Figure 5. Stationary Valve (Showing Rotary Valve Timing).

Section IV - INSTALLATION AND OPERATION INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawing listed in Table 1 will show installation dimensions, port locations and application data for the HMA-1000 and HMA-2000 Series motors.

B. MOUNTING AND DRIVE CONNECTIONS

CAUTION

Motor shafts are designed to be installed in couplings or pulleys with a slip fit. Pounding can injure the bearings. Shaft dimensions and tolerances are shown on the installation drawing.

1. Direct Mounting - A pilot on the orbital motor mounting flange (Figure 6) assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad. Care should be exercised in tightening the mounting screws to prevent misalignment.

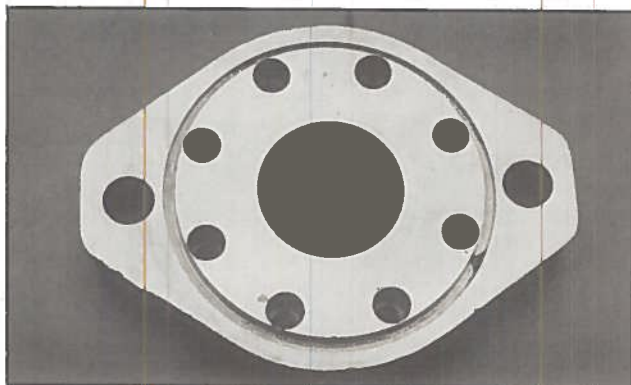


Figure 6. Pilot Flange for the High Torque Low Speed Motors.

2. Indirect drive can be used with these motors. However, for applications that approach the motors maximum side load capabilities, Vickers engineering approval must be obtained.

C. SHAFT ROTATION

Motors are capable of rotating in either direction. To reverse motor direction, simply reverse flow direction.

D. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling.

NOTE

For instructions on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used. Connecting lines (hose or tubing) should be at least the SAE port size of the unit.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of fluid flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Fluid in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selec-

tion of fluid assures satisfactory life and operation of system components with particular emphasis on hydraulic motors. Any fluid selected for use with motors is acceptable for use with valves or pumps.

Data sheet M-2950-S for fluid selection is available from Vickers Technical Publications, Troy, Michigan. Fluid recommendations noted in the data sheet are based on our experience in industry as a hydraulic component manufacturer. Where special considerations indicate a need to depart from the recommended fluids or operating conditions, see your Vickers representative.

CLEANLINESS

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of fluid to prevent introduction of contaminants into the system.
3. Provide continuous filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of system from entry of airborne contamination by sealing the system and/or by proper filtration of the air.
5. During usage, proper fluid filling and servicing of filter, breathers, reservoir, etc., cannot be over emphasised.

6. Thorough precaution should be taken by proper system and reservoir design, to insure that aeration of the fluid will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause excessive noises are:

1. Very high viscosities at cold or low start-up temperatures can cause pump noises due to cavitation.
2. Running with a moderately high to high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.
3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings or by fluid discharging above the fluid level in the reservoir. Air in the fluid results in a noise similar to cavitation.

F. OVERLOAD PROTECTION

Relief valves limit pressure in the system to a prescribed maximum and protect components from excessive pressure. The setting of a relief valve depends on the work requirements of the system components.

Section V - SERVICE AND MAINTENANCE

A. SERVICE TOOLS

The following standard tools for overhauling the HTLS orbital motor are shown below:

STANDARD TOOLS

1. A three-sixteenth hex key wrench with socket adapter.
2. A one-half inch socket wrench and ratchet.
3. Torque wrench covering the range of 100-200 in. lbs.
4. Soft tip hammer.
5. Cleaning solvent.
6. Shop air (90 PSI).
7. Drill motor and small drill bit (1/16 inch).
8. A thin blade screwdriver.
9. A small dental pick or sharp pointed tool.

SPECIAL TOOLS

Special tools are shown in Figures 7 and 8.

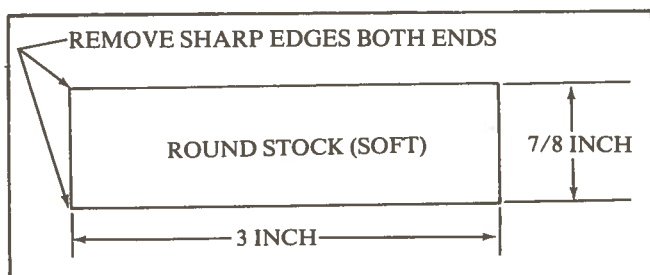


Figure 7. A length of 7/8 inch round stock for removal of the shaft and bearing S/A from the body.

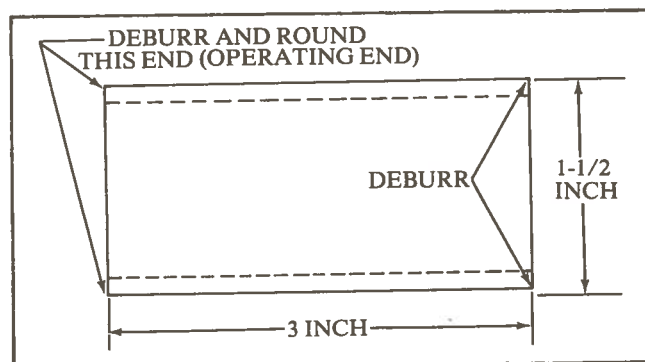


Figure 8. Shaft seal installation tool

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening of the reservoir, extensive damage to the pump and motor can occur resulting in noisy and/or erratic operation of the system..

2. Clean fluid is the best insurance for long service life, therefore, the reservoir should be checked periodically for dirt or other contamination.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a high pressure drop. This can force particles through the filter that would ordinarily be trapped, or can cause the by-pass to open resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can damage the motor and other components. If bubbles are seen, locate the source of the air and seal the leak (see Table 3).

5. A motor which is running excessively hot or noisy is a potential failure. Should a motor become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be pumped through a 10 micron (absolute) filter. It is important that fluid be clean and free of any substance which could cause improper operation or wear of the hydraulic motor, or other units. Therefore, the use of cloth to strain the fluid must be avoided to prevent lint from getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the load.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. The lubrication of shaft couplings should be as specified by their manufacturers. Coat shaft splines with a dry lubricant (Molycoat or equivalent) to prevent wear.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if authentic Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutes may result in early failure. Part numbers are shown in Table 4.

G. PRODUCT LIFE

The longevity of these products is dependent upon environment, duty cycle, operating parameters and system cleanliness. Since these parameters vary from application to application, the ultimate user must determine and establish the periodic maintenance required to maximize life and detect potential component failure.

H. TROUBLE SHOOTING

Refer to Table 3 for trouble shooting data.

Trouble	Cause	Remedy
I. Excessive noise.	Low fluid level. in the reservoir.	Fill reservoir to proper level with the recommended fluid. DO NOT over fill or damage may result.
	Air in the system.	1. Open reservoir cap and operate hydraulic system until purged. 2. "Bleed" hydraulic lines at highest point downstream of pump and while system is under pressure.
	Vacuum condition.	Check inlet pump (suction) lines and fittings for air leaks.
	Fluid too thick.	Be certain correct type of fluid is used for refilling or adding to the system.
	Cold weather.	Run hydraulic system until units are warm to the touch and noise disappears.
II. Overheating.	Internal leakage.	If established that excessive internal leakage exists, return vehicle to maintenance shop for evaluation and repair.
	Heat exchanger not functioning.	Locate trouble and repair or replace.
	Fluid level low.	Add fluid to operating level.
III. System not developing pressure.	Relief valve open.	Repair or replace relief valve.
	Loss of fluid, internal slippage.	1. Return vehicle to maintenance shop for repair of hydraulic system. 2. Replace valving and rotating group if defective. 3. Replace urethane seal and shim washer in body.
IV. Loss of fluid.	1. Ruptured hydraulic lines. 2. Loose fittings. 3. Leaking seals.	Check all external connections, tubing and hoses. Tighten connections, replace ruptured tube or hose.
V. Miscellaneous.	1. Misadjusted or broken control linkage. 2. Disconnected or broken drive mechanisms.	Locate and repair.

Table 3. Trouble Shooting Chart

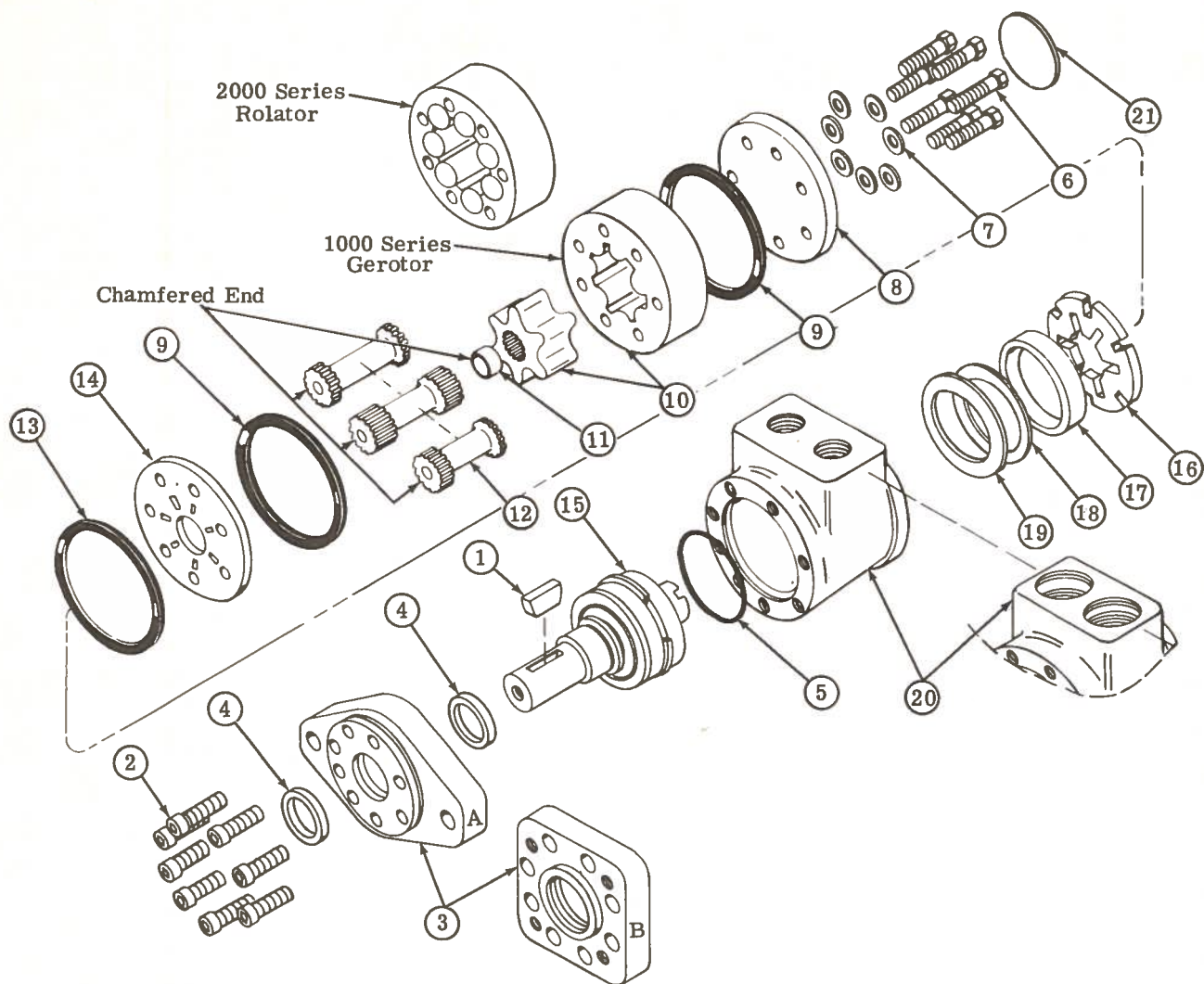


Figure 9. Exploded View

DESCRIPTION	MODEL REFERENCE
HMA-****-A**-10	A
HMA-****-B**-10	B
HMA-****-D**-10	C
HMA-****-P*-10	D
HMA-****-S*-10	E
HMA-****-T*-10	F
HMA-****-W*-10	G
HMA-****-O-10	H
HMA-****-P-10	I
HMA-1030-***-10	J
HMA-1045-***-10	K
HMA-1062-***-10	L
HMA-1103-***-10	M
HMA-1119-***-10	N
HMA-1149-***-10	O
HMA-1179-***-10	P
HMA-1238-***-10	Q
HMA-2042-***-10	R
HMA-2058-***-10	S
HMA-2096-***-10	T
HMA-2111-***-10	U
HMA-2139-***-10	V
HMA-2167-***-10	W
HMA-2223-***-10	X

INDEX NO.	PART NO.	DESCRIPTION	UNITS PER ASSY.	USED IN MODEL
1	1617	Woodruff Key	1	G
1	22971	Square Key	1	D
2	926318	Flange Fastener Kit	1	*
3	675919	Two Bolt Flange	1	A
3	675918	Four Bolt Flange	1	B
4	▲	Shaft Seal (Outer Dust)	1	*
4	▲	Shaft Seal (Inner Pressure)	1	*
5	▲	Flange "O" Ring Seal	1	*
6	926311	Fastener Kit (Cover) (See Table 5)	1	J,K,R
6	926312	Fastener Kit (Cover) (See Table 5)	1	L,S
6	926313	Fastener Kit (Cover) (See Table 5)	1	M,T
6	926314	Fastener Kit (Cover) (See Table 5)	1	N,U
6	926315	Fastener Kit (Cover) (See Table 5)	1	O,V
6	926316	Fastener Kit (Cover) (See Table 5)	1	P,W
6	926317	Fastener Kit (Cover) (See Table 5)	1	Q,X
7	▲	Flat Washers (Compression)	7	*
8	676996	End Cap	1	*
9	▲	Square Cut Seal	2	*
10	675929	Gerotor Assy. (HMA-1030)	1	J
10	675930	Gerotor Assy. (HMA-1045)	1	K
10	675931	Gerotor Assy. (HMA-1062)	1	L
10	675932	Gerotor Assy. (HMA-1103)	1	M
10	675933	Gerotor Assy. (HMA-1119)	1	N
10	675934	Gerotor Assy. (HMA-1149)	1	O
10	675935	Gerotor Assy. (HMA-1179)	1	P
10	675936	Gerotor Assy. (HMA-1238)	1	Q
10	675937	Rolator Assy. (HMA-2042)	1	R
10	675938	Rolator Assy. (HMA-2058)	1	S
10	675939	Rolator Assy. (HMA-2096)	1	T
10	675940	Rolator Assy. (HMA-2111)	1	U
10	675941	Rolator Assy. (HMA-2139)	1	V
10	675942	Rolator Assy. (HMA-2167)	1	W
10	675943	Rolator Assy. (HMA-2223)	1	X
11	676990	Spacer	1	L,M,N,S,T,U,
11	676991	Spacer	1	O,V
11	676992	Spacer	1	P,W
11	676993	Spacer	1	Q,X
12	675926	Universal	1	M,N,O,P,Q, T,U,V,W,X
12	675927	Universal	1	K,L,R,S
12	675928	Universal	1	J
13	▲	Square Cut Seal	1	*
14	●	Stationary Valve	1	*
15	675921	Shaft & Bearing S/A (P - Straight)	1	D
15	675920	Shaft & Bearing S/A (W - Woodruff)	1	G
15	675922	Shaft & Bearing S/A (S - Spline)	1	E
15	675947	Shaft & Bearing S/A (D - Pin Hole)	1	C
15	682683	Shaft & Bearing S/A (T - Tapered)	1	F
16	●	Rotary Valve	1	*
17	●	Wear Ring	1	*
18	●	Shim Washer	1	*
19	●	Urethane Compression Washer	1	*
20	675924	Body Block 1/2" NPT Ports	1	I
20	675925	Body Block 3/8" SAE "O" Ring Port	1	H
21	452008	Nameplate (pressure sensitive adhesive label)	1	*
-	926453	Manifold Kit	1	*
-	▲ 676994	Included in Seal Kit	1	*
-	● 676995	Included in Rotary Valve Kit	1	*

Table 4. Model Verses Parts Listing

NOTE

*These parts are used in all models.

NOTE

Individual parts of assemblies, subassemblies and kits are not available for sale.

Section VI - OVERHAUL

A. GENERAL

CAUTION

Block vehicle if it is on a slope. The (HTLS) motor cannot act as a parking brake.

CAUTION

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure.

Clean the outside of the unit thoroughly to prevent entry of dirt into the system, then drain fluid from the vehicle hydraulic system. Be sure to use new clean fluid when restoring the unit to service.

After removing the motor from the vehicle and before disassembly, cap or plug all ports and disconnected hydraulic lines.

CAUTION

Absolute cleanliness is essential when working on a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

Periodic maintenance of the motor will generally not require disassembly to the extent described here. In general, disassembly is accomplished in the item number sequence shown in Figure 9. Special procedures are included in the following steps.

NOTE

Discard and replace all "O" rings, square cut seals and shaft seals removed during disassembly.

B. DISASSEMBLY OF THE HTLS ORBITAL MOTOR

NOTE

Refer to Figure 9 throughout this procedure.

1. Secure the motor in a vise with shaft up. Remove shaft key (1) from shaft and bearing S/A (15). A center punch and small hammer is useful if the key is tight.

2. Remove eight screws (2) from mounting flange (3). Use a 3/16 inch socket key wrench.

3. Remove mounting flange (3) from body (20). Pry the inner and outer shaft seals (4) from mounting flange using a thin blade screwdriver. Be careful not to scratch the shaft seal bores. Remove "O" ring (5) and discard.

4. Relocate motor in vise so cover (8) is up. Remove seven screws (6) and flat compression washers (7) from end cover (8). Use a 1/2 inch socket and ratchet. Discard the compression washers (7).

5. Remove end cover (8).

6. Remove gerotor/rolator set (rotating group) (10), and spacer (11), if used, from body (20). Remove and discard square cut seals (9).

7. Remove stationary valve (14) and square cut seal (13) from body (20).

8. Slide universal shaft (12) from shaft and bearings S/A (15).

9. Relocate body in vise with shaft horizontal. Insert special tool (Figure 7) into the spline area opening of shaft and bearing S/A (15). With a soft tipped hammer, gently tap shaft and bearing S/A (15) from body (20). This will release rotary valve (16) from the shaft and bearing S/A.

10. Remove rotary valve (16) from within the body, then remove wear ring (17). Do not remove the shim washer (18) or urethane washer (19) at this time unless it is obvious the stationary and rotary valves are defective. If the rotary valve assembly is defective, remove shim (18) and urethane washer (19) as follows:

a. Clean and degrease body, then blow shop air around the shim washer area. This process can lift the shim out of the body cavity. Use a small sharp pointed tool (dental pick or a sharpened paper clip) to help remove shim and urethane compression washer.

b. Alternate method: Drill a small hole in shim (18) and remove with a sharp pointed tool. Remove the urethane compression washer (19).

C. INSPECTION, REPAIR AND REPLACEMENT

NOTE

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important.

NOTE

Replace all parts that do not meet the following specifications.

1. Inspect the shaft key (1) for wear and burrs. Replace if defective (see Table 4).

2. Inspect flange screws (2) and cover screws (6) for cross threads and worn heads. Replace as a fastener kit if screws are defective. See Tables 4 and 5.

CAUTION

All bolts used on the flange and cover are grade 8 and sized as noted in Tables 4 and 5.

3. Inspect flange (3) for scratches, burrs, chips and cracks in the shaft seal area. Replace if part cannot be salvaged. A small file can be very useful to clean burrs from the edges of the flange. If the mounting bolt holes are cracked, replace the flange (see Table 4).

4. Inspect the end cover (8) for flatness of the inner surface. Minor imperfections should be lapped to provide a smooth finish.

MODEL HMA-****-		ROTATING GRPS. (10) *Width inches		SPACER (11) *Length inches	UNIVERSAL (12) *Length inches	COVER FASTNER KIT (6) *Length inches
1000	2000	1000	2000			
1030	—	675929 *0.25	—	OMIT —	675928 *2.30	926311 *5/16-18 x 1.5
1045	2042	675930 *0.375	675937 *0.375	OMIT —	675927 *2.40	926311 *5/16-18 x 1.5
1103	2096	675931 *0.5	675938 *0.5	676990 *0.137	675927 *2.40	926312 *5/16-18 x 1.75
1062	2058	675932 *0.875	675939 *0.875	676990 *0.137	675926 *2.875	926313 *5/16-18 x 2.0
1119	2111	675933 *1.0	675940 *1.0	676990 *0.137	675926 *2.875	926314 *5/16-18 x 2.25
1149	2139	675934 *1.25	675941 *1.25	676991 *0.387	675926 *2.875	926315 *5/16-18 x 2.50
1179	2167	675935 *1.5	675942 *1.5	676992 *0.637	675926 *2.875	926316 *5/16-18 x 2.75
1238	2223	675936 *2.0	675943 *2.0	676993 *1.137	675926 *2.875	926317 *5/16-18 x 3.25

Table 5. Rotating Group Parts Cross Reference For All Units.

5. Inspect the rotating group assembly (10) for looseness, worn or broken splines, and a good finish on the inner rotor and outer stator. Also, if excessive leakage was noted before removing unit, replacement on general principles is a wise precaution. It is very difficult to determine if a rotating group has excessive leakage.

6. Visually inspect universal (12) for worn or broken splines. If the universal's splines are broken or worn, or the splines within the rotating group were defective, replacement of both parts are required. See Table 5 for replacement parts.

7. Check the mating surfaces of stationary valve (14) and rotary valve (16) for flatness, wear and pick up. If the valve assembly is defective, do not attempt to lap the valve parts. Replacement of both the stationary and rotary valve along with shim washer (18), and urethane compression washer (19) is required. to remove shim washer (18) and urethane compression washer (19), refer to step VI.B.10. See Figures 4 and 9 and Table 4.

8. Check wear ring (17) for cracks and scratches across the running seal surface. If the ring's wear surfaces are smooth and look clean and shiny, replacement is unnecessary. However, if the wear surface is rough and pick up or galling is present, replace the wear ring and the rotary valve S/A together as an assembly. Replace shim washer (18) and urethane compression washer (19) simultaneously at this time. Both parts are in the rotating valve S/A kit noted in Table 4.

9. Inspect shaft and bearing subassembly (15) for wear in the shaft seal area. If wear is greater than 0.005 inch FIM (full indicator reading - formerly TIR, total indicator reading), replacement of the shaft and bearing S/A is required or leakage will occur at the shaft seal. Inspect the spline within the shaft for broken teeth and excessive wear. Make sure both bearings turn freely on the shaft. If the spline inside the shaft has worn or broken teeth and/or the bearings are defective, replace shaft and bearing S/A (15) (see Table 4).

10. Check body (20) for cross threaded ports, cracks and burrs. Clean up burrs with a small file or an India stone. Replace if cracked or port threads are defective (see Table 4).

D. ASSEMBLY

NOTE

In general, assembly is performed in the reverse item number sequence shown in Figure 9. Special procedures are included in the following steps. Flood all parts with system fluid to provide initial lubrication at assembly.

NOTE

Order a new seal kit and repair parts for the unit being serviced. The seal kit and part numbers are tabulated in Table 4.

1. Install shaft and bearing S/A (15) into body (20) as follows:

a. Place body (20) on a flat surface with the small diameter flange end up.

b. Place the shaft and bearing S/A (15) into body (20) opening and align bearing with I.D. of body. Gently tap the shaft end with a soft tip hammer to start the bearing evenly, then continue to drive it into body (20) with the soft tipped hammer until it bottoms against an internal shoulder. The outer bearing race will extend about 1/8 inch above the surface of the body when completed.

2. Install "O" ring (5) around the exposed bearing race and into the "O" ring groove of body (20).

3. Place flange (3) on a flat surface with the small seal opening down (the large seal opening up).

4. Install the larger pressure shaft seal (4) with lip side of seal pointing up. Be careful not to cut the seal during installation. A short length of 1-1/2 inch thin wall tube cut square and deburred can be used to press the new seal in place (see Figure 8).

5. Turn flange (3) over and install dust seal (4). The lip of the dust seal will also be up out of the flange. Gently tap the dust seal flush in place with a small block of hardwood.

6. Lubricate both seals and shaft seal area with system fluid. Then, carefully slide flange (3) with seals (4) in place over the shaft. Align bolt holes and thread flange bolts (2) in place. Cross torque the bolts to 11.3 N.m (100 lb. in.).

7. Position body (20) in a vise with the open end up. If the urethane compression washer (19) and shim washer (18) were removed during inspection, install the new parts in place within the groove of the body. See Figure 9 for parts location.

8. Install wear ring (17) in place over shim washer (18).

9. Install the rotary valve (16). Make sure the rounded edges of the valve are pointing upward (see Figure 4). The tang of the rotary valve fits on the shaft. Start the valve on the shaft with a clean, soft tipped hammer. Then, work down into place against wear ring (17) by tapping around the perimeter. Wipe the surface of rotary valve (16) clean with system fluid.

10. Locate the three-thirty (3:30) bolt hole timing position shown in Figure 5. Turn the drive shaft until one of the rotary valves's outer porting slots point at the three-thirty bolt hole position. This times the rotary valve.

11. Install square cut seal (13) in the seal groove of body (20).

12. Place stationary valve (14) over rotary valve (16) with the rounded edge of the stationary valve toward the rotary valve (see Figure 5). The timing of the two valve parts should be as shown in Figure 5.

13. Install universal (12) with the chamfered end located within the shaft and bearing S/A.

14. Install two square cut seals (9) into the seal grooves of rotating group (10).

15. Install rotating group (10) as shown in Figure 10. The inner rotor must be positioned as shown and rotary valve timing must still be in the Figure 5 position. Align the bolt holes of rotating group (10) and stationary valve (14) with body (20). Thread in two screws (6) loosely, opposite of each other. This will keep the parts in position.

NOTE

If the rotating group is being changed to a different CIR rating, the cover bolt lengths may require changing. Refer to Table 5 for cover bolt kit information.

16. Refer to Table 5 and see if spacer (11) is required for the rotating group being installed. Insert spacer (11) into the inner rotor of the rotating group, if required.

17. Carefully remove the two cover screws (6). Place cover (8) in position over rotating group (round edge of cover will be directed toward the outside of motor). Install a new compression flat washer (7) over each cover screw (6) and thread cover screws in place. Cross torque the cover screws to 22.6 N.m (200 lb. in.).

18. Install shaft key (1) into shaft and bearing S/A (15), if required.

19. If the unit has been modified to a different rotating group, replace nameplate (21) located on the back cover. This completes overhaul of the HTLS, HMA Series Motor.

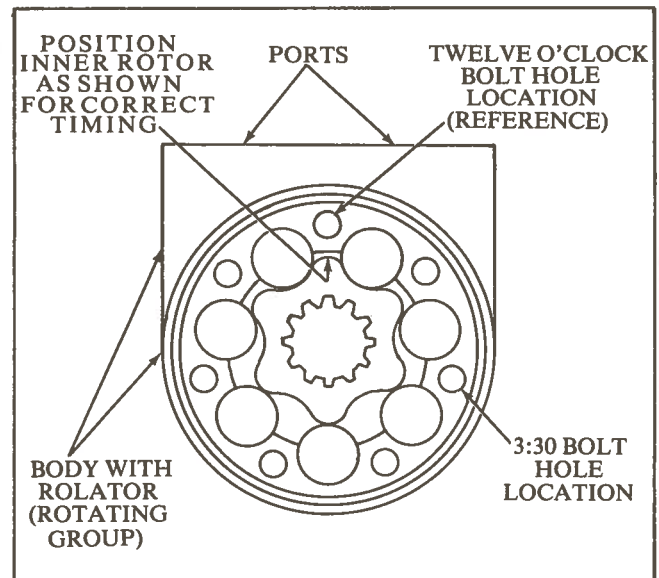


Figure 10. The reference twelve o'clock and 3:30 bolt hole positions showing gerotor/rolator inner rotor timing.

Section VII - TEST

If test equipment is available, the motor should be tested at the recommended flow, speeds and pressures shown on the installation drawing (see Table 1).

NOTE

Refer to the general procedures concerning fluid recommendations before placing the motor into service.





Litho in U. S. A.

Service Parts Information



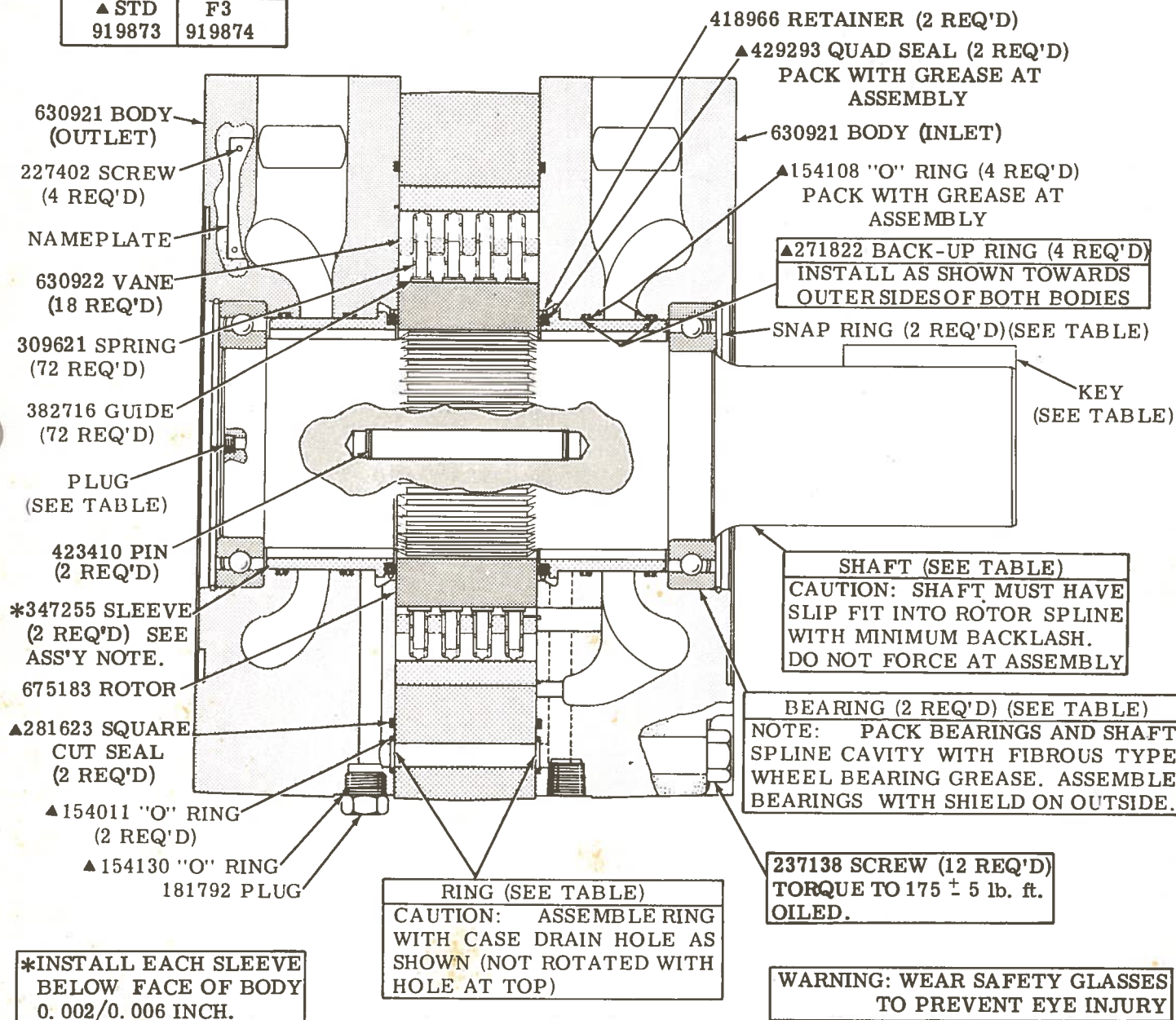
**HIGH TORQUE
LOW SPEED
VANE MOTORS**

MHT-250-*1-30-S30

**STD/F3 SEAL KIT
CROSS REFERENCE**

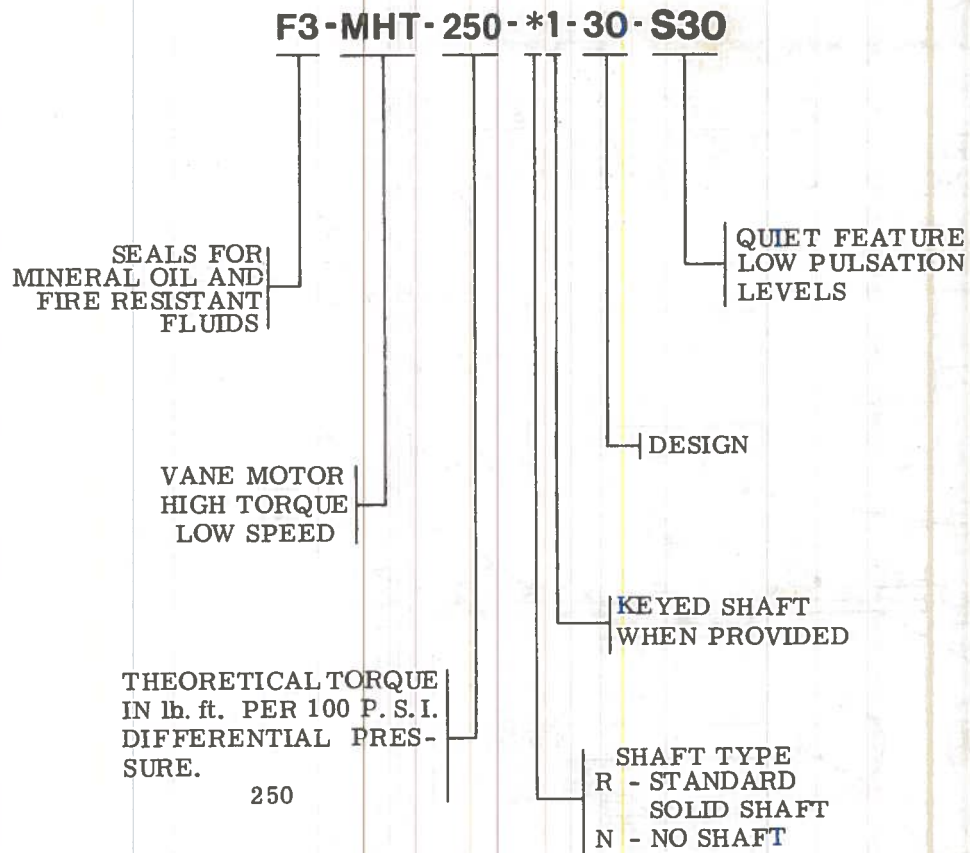
▲ STD	F3
919873	919874

MODEL	SHAFT	SNAP RING	KEY	BEARING	PLUG	RING
MHT-250-N1-30-S30	—	—	—	—	—	343826
MHT-250-R1-30-S30	345769	354386	306439	310539	7074	



CAUTION: WHEN ASSEMBLING CARTRIDGE, INSERT VANES IN ROTOR SLOTS AT THE MINOR DIAMETER OF CAM RING. ROTATE CARTRIDGE ONE COMPLETE REVOLUTION PRIOR TO ASSEMBLY WITH BODIES. THIS PREVENTS MISALIGNMENT OF SPRINGS AND GUIDES.

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Service Parts Information

**HIGH TORQUE
LOW SPEED
VANE MOTORS**

MHT 750-*1-30-S30

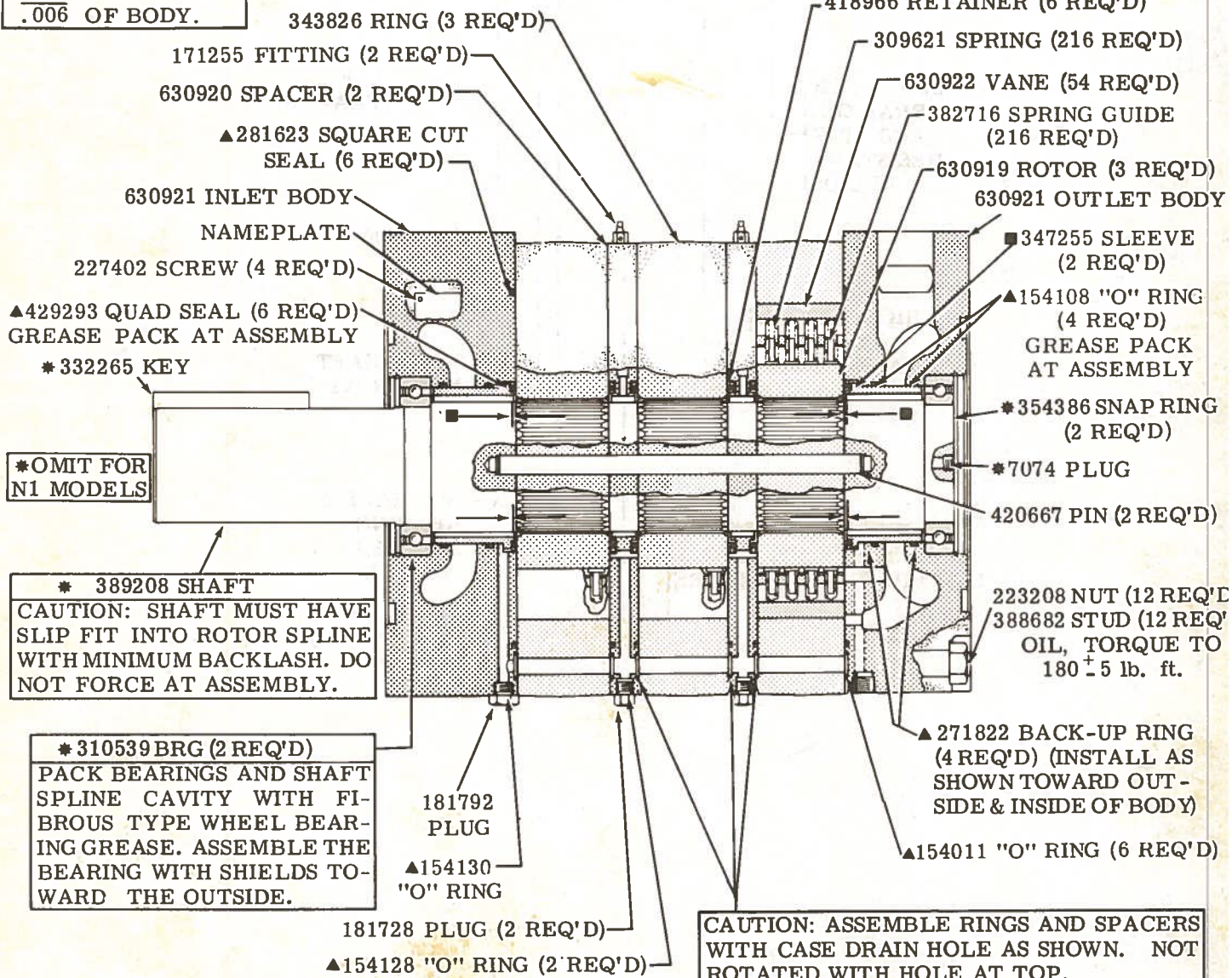
VICKERS
A TRIMCOVA COMPANY

**WARNING: WEAR SAFETY GLASSES
TO PREVENT EYE INJURY.**

**▲ INCLUDED IN
919881 SEAL KIT**

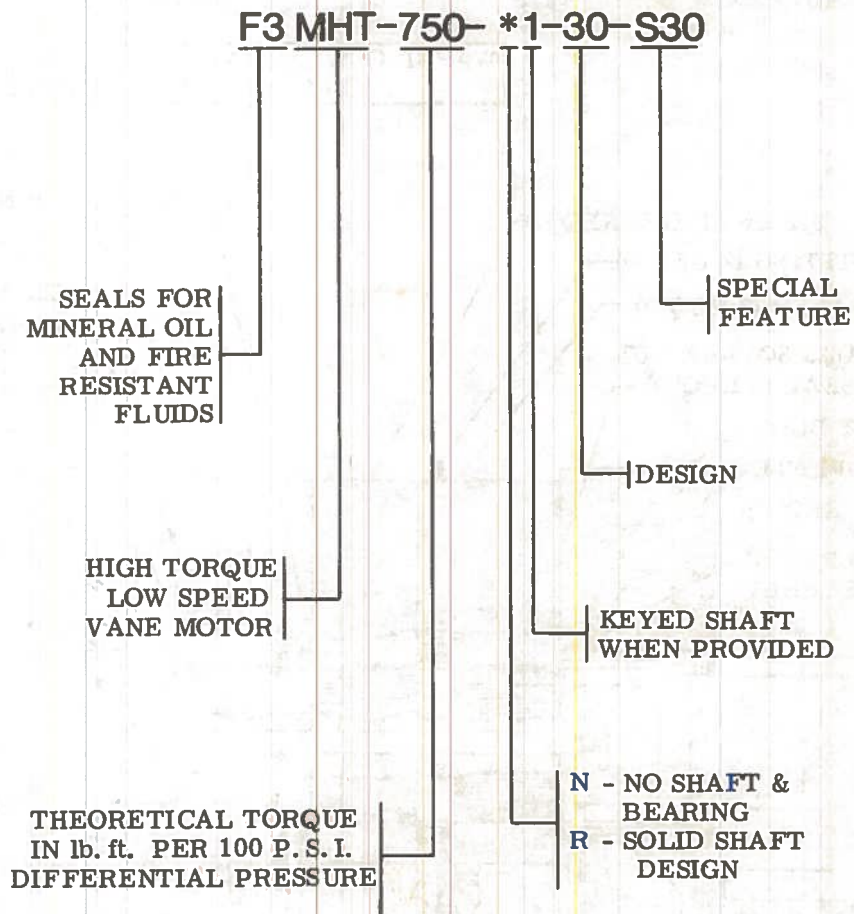
**F3 EQUIVALENT
SEAL KIT 919882**

**■ SLEEVES MUST BE
.002 BELOW FACE
.006 OF BODY.**



CAUTION: WHEN ASSEMBLING CARTRIDGE, INSERT VANES IN ROTOR SLOTS AT THE MINOR DIAMETER OF CAMRING. ROTATE CARTRIDGE ONE COMPLETE REVOLUTION PRIOR TO ASSY WITH BODIES. THIS PREVENTS MISALIGNMENT OF SPRINGS AND GUIDES. MAKE SURE THE MARKED ROTOR TOOTH OF EACH CARTRIDGE IS IN LINE BEFORE INSTALLATION OF SHAFT.

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

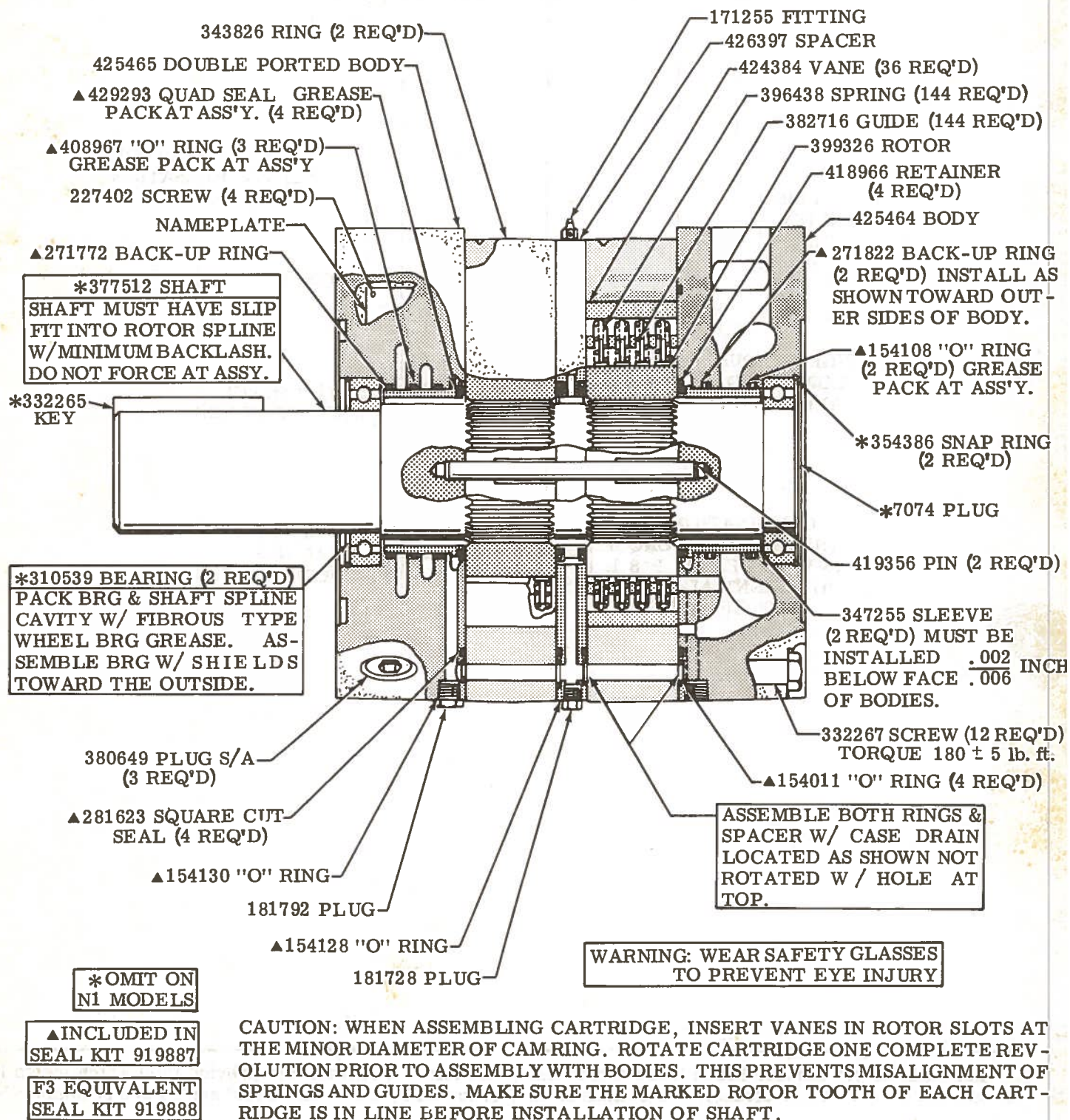
Litho in U. S. A.

Service Parts Information



MULTI-TORQUE VANE MOTORS

MHT 500/250/250-*1-30-S27



Vickers, Incorporated
1401 Crooks Road
Troy, Michigan 48084

Revised 11-1-85

I-3749-S

MODEL CODE BREAKDOWN

F3-MHT-500/250/250-(*)1-30-S27

MULTI-FLUID
CAPABILITY
(VITON SEALS)

HIGH TORQUE
LOW SPEED
VANE MOTOR

COMBINATIONS OF
THEORETICAL TORQUE
IN lb. ft. PER 100 P.S.I.
DIFFERENTIAL PRESS.
500/250/250

QUIET FEATURE
LOW PULSATION
LEVELS

DESIGN

KEYED SHAFT
WHEN PROVIDED

N - NO SHAFT &
BEARINGS
R - SOLID SHAFT

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 13/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

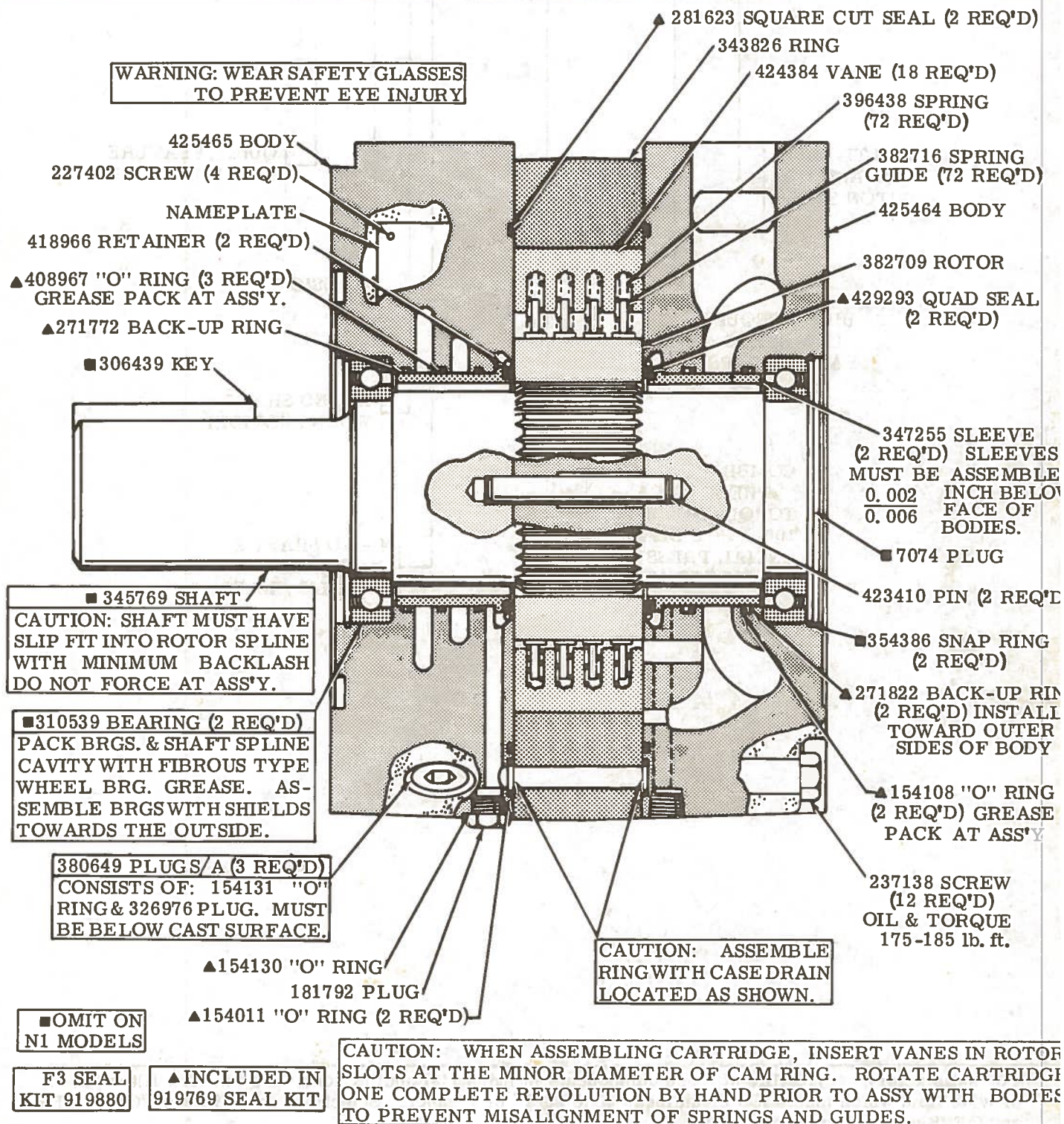
Litho in U. S. A.

Service Parts Information

VICKERS
A TRIMONA COMPANY

MULTI-TORQUE VANE MOTORS

MHT 250/125/125-*1-30-S27



Vickers, Incorporated
P.O. Box 302
Troy, Michigan 48007-0302

Revised 11-1-85

I-3747-S

MODEL CODE BREAKDOWN

F3 - MHT - 250/125/125 - (*)1 - 30 - S27

MULTI-FLUID
CAPABILITY
(VITON SEALS)

QUIET FEATURE
LOW PULSATION

HIGH TORQUE
LOW SPEED
VANE MOTORS

DESIGN

KEYED SHAFT
WHEN PROVIDED

COMBINATIONS OF
THEORETICAL
TORQUE IN lb.ft. PER
100 P.S.I. DIFFER-
ENTIAL PRESSURE.
250/125/125

N - NO SHAFT &
BEARINGS
R - SOLID SHAFT

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

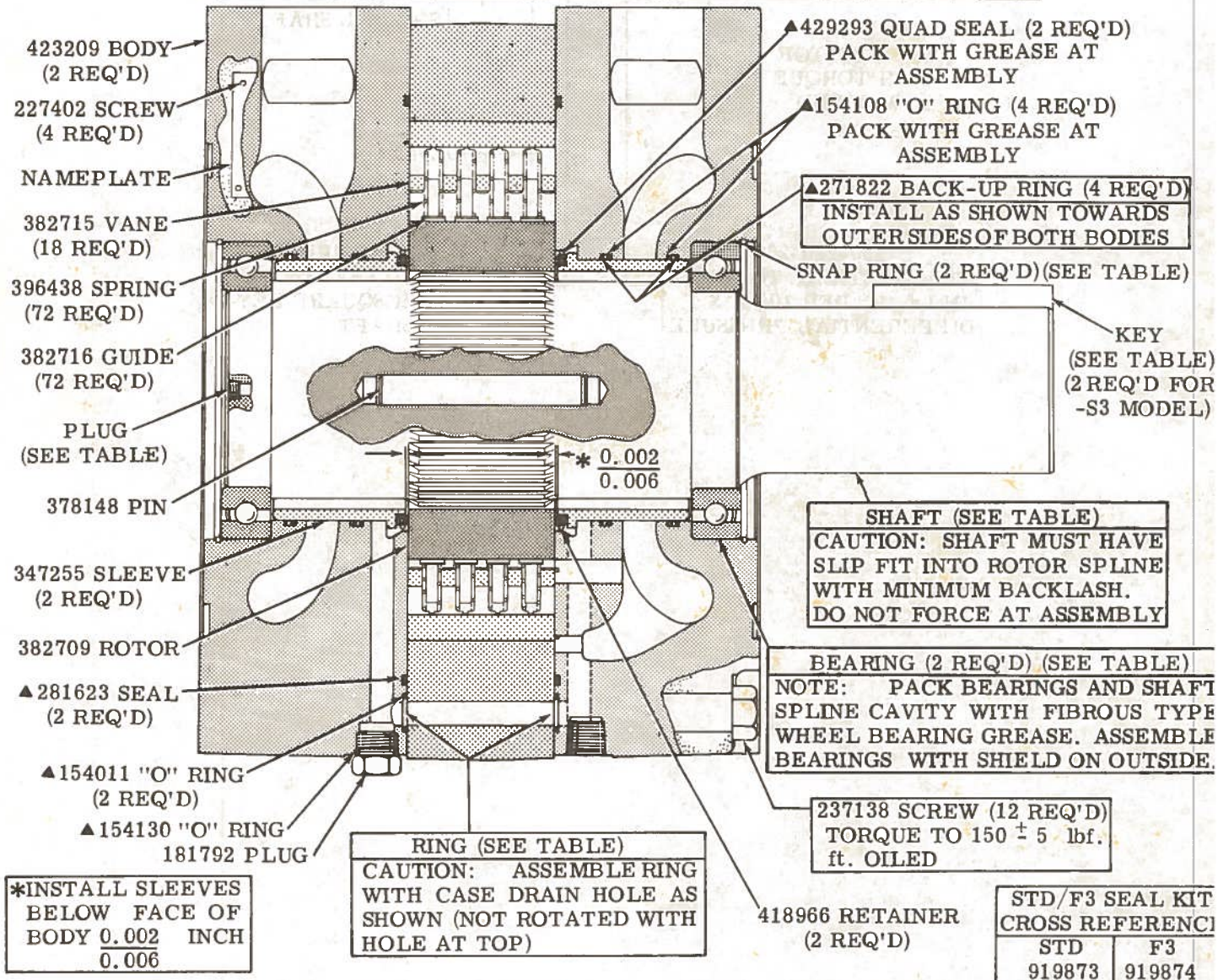
Service Parts Information

VICKERS
A TRIHIOVA COMPANY

**HIGH TORQUE
LOW SPEED
VANE MOTORS**

MHT 190/220/250

MODEL	SHAFT	SNAP RING	KEY	BEARING	PLUG	RING
MHT-190-N1-30	—	—	—	—	378603	364468
MHT-190-R1-30	345769	354386	306439	310539	7074	—
MHT-220-N1-30	—	—	—	—	378603	375223
MHT-220-R1-30	345769	354386	306439	310539	7074	—
MHT-250-N1-30	—	—	—	—	378603	—
MHT-250-R1-30	345769	354386	306439	310539	7074	343826
MHT-**-0-R1-30-S3	401966	—	—	—	—	—



CAUTION: WHEN ASSEMBLING CARTRIDGE, INSERT VANES IN ROTOR SLOTS AT THE MINOR DIAMETER OF CAM RING. ROTATE CARTRIDGE ONE COMPLETE REVOLUTION PRIOR TO ASSY WITH BODIES. THIS PREVENTS MISALIGNMENT OF SPRINGS AND GUIDES

Vickers, Incorporated
P.O. Box 302
Troy, Michigan 48007-0302

Revised 11-1-85

I-3717-S

MODEL CODE BREAKDOWN

(F3) - MHT-0-*1-30-(S3)**

MULTI-FLUID
CAPABILITY
(VITON SEALS)

VANE MOTOR
HIGH TORQUE
LOW SPEED

190-220-250
THEORETICAL TORQUE
IN lbf. ft. PER 100 P.S.I.
DIFFERENTIAL PRESSURE

SPECIAL SHAFT

DESIGN

SHAFT TYPE
R1 - SOLID SHAFT
WITH SQUARE KEY
N1 - NO SHAFT

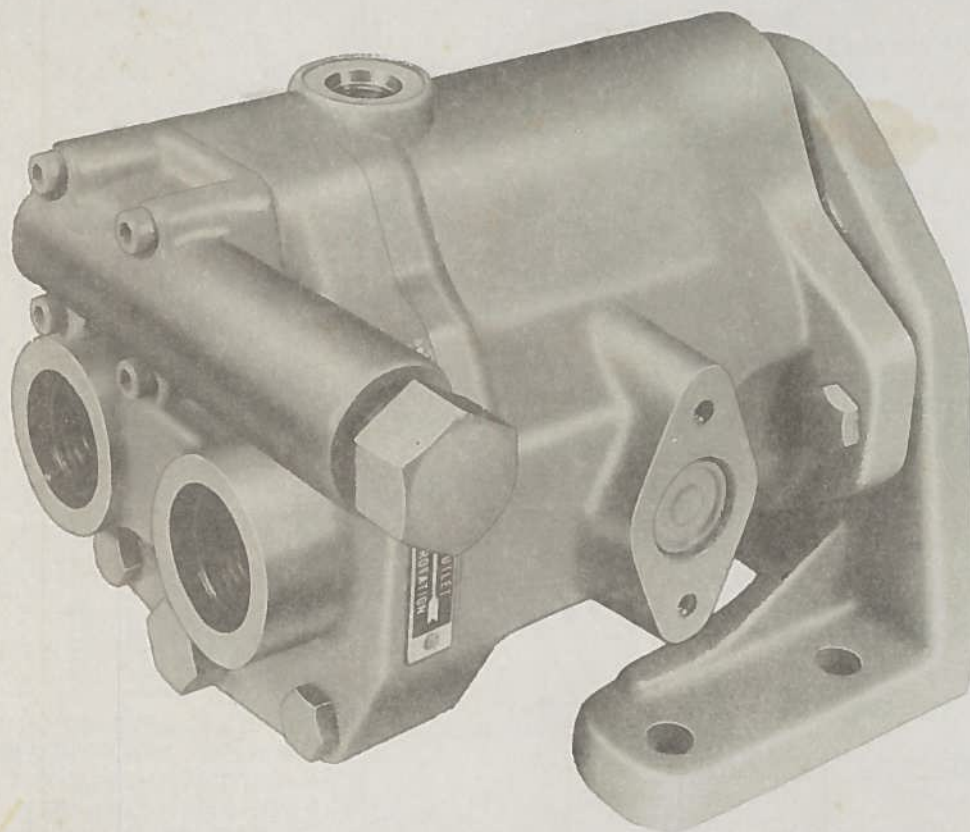
For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

Service Parts Information

**5 and 6 GPM
Variable Inline
Piston Units**

MVB5-(F)UDY-20-*(L)-10
PVB5-(F)**Y-20-*(C)(*)-1*
PVB6-(F)**Y-20-*(C)(*)-1*



Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 5-1-87

I-3280-S

PRESS BEARING FLUSH
WITH INSIDE SURFACE
OF HOUSING

YOKE

HOUSING

319243 PINTLE
(REF.)

317572
BEARING
(REF.)

PINTLE BEARING ASSEMBLY NOTE
MAKE CERTAIN THE BEARING O. D. SURFACE
AND THE MATING SURFACE IN THE HOUSING
IS CLEAN. APPLY SEALING COMPOUND
(LOCTITE A (10-1) OR EQUIVALENT) TO THE
BEARING O. D. AND PRESS IN PLACE.

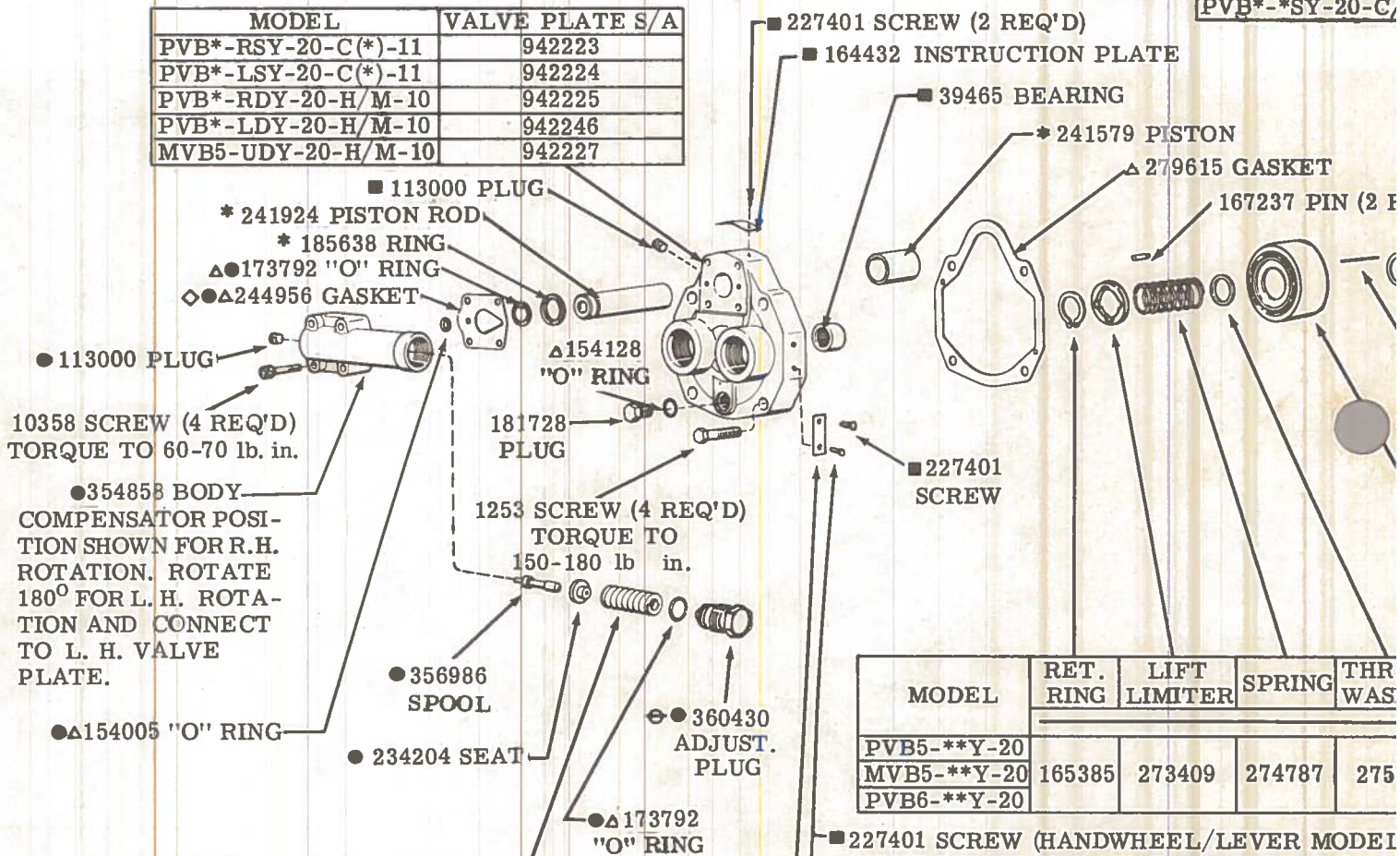
CAUTION

DO NOT ALLOW SEALING COMPOUND
TO CONTACT THE BEARING NEEDLES.

BEARING

MODEL
PVB*-SY-20-C/

MODEL	VALVE PLATE S/A
PVB*-RSY-20-C(*)-11	942223
PVB*-LSY-20-C(*)-11	942224
PVB*-RDY-20-H/M-10	942225
PVB*-LDY-20-H/M-10	942246
MVB5-UDY-20-H/M-10	942227



MODEL	RET. RING	LIFT LIMITER	SPRING	THR WAS
PVB5-YY-20				
MVB5-YY-20	165385	273409	274787	275
PVB6-YY-20				

PRESSURE RANGE (PSI)	COMPENSATOR SUBASSY	SPRING
(C)250-3000 (5)	942158	239371
250-2000 (6)		
(CM)250-1500	942159	265693

● INCLUDED IN PRESSURE
COMPENSATOR SUBASSYS
SHOWN IN TABLE.

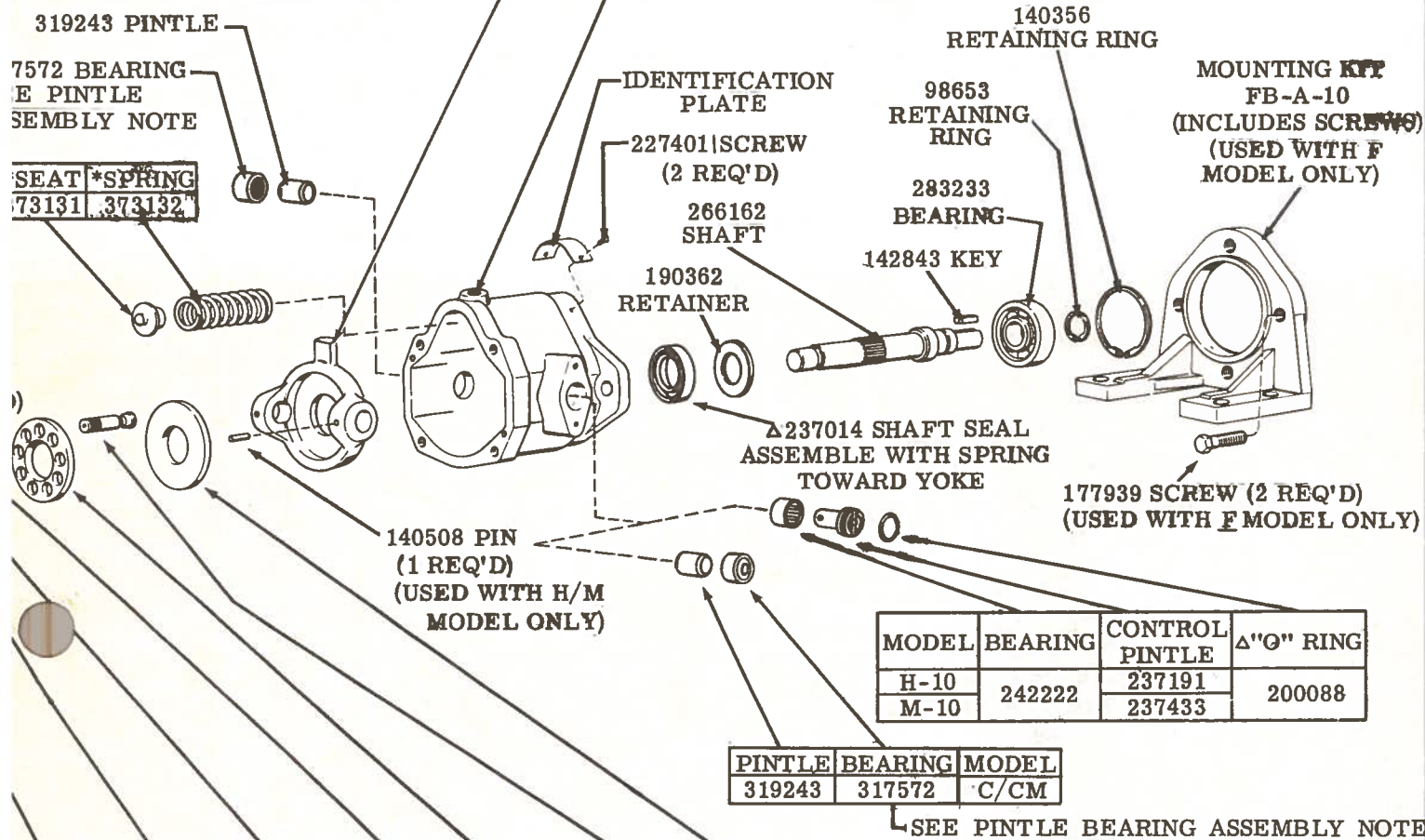
■ INCLUDED IN
VALVE PLATE S/A

⊖ CAUTION
MODEL PVB6 COMPENSATOR
PRESSURE ADJUSTMENT SHALL
NOT EXCEED 2000 PSI.

NOTE: TYPE 'C' & 'CM' COMPENSATOR
CONTROL PARTS SHOWN. SEE BACK
PAGE FOR MANUAL CONTROLS. REFER
TO PARTS DRAWING I-3243-S FOR 'CVP'
PRESSURE LIMITING & LOAD SENSING
COMPENSATOR CONTROL.

MODEL	YOKE	HOUSING
PVB*-*D*Y-20-H-1*	237192	436462
PVB*-*D*Y-20-M-1*		308334
PVB*-*S*Y-20-C(*) (*)-1*	231557	

⚠CAUTION
POSITION GASKET WITH SMALL END
OF TEARDROP HOLE POINTING IN
DIRECTION OF COMPENSATOR ADJ-
USTING PLUG.



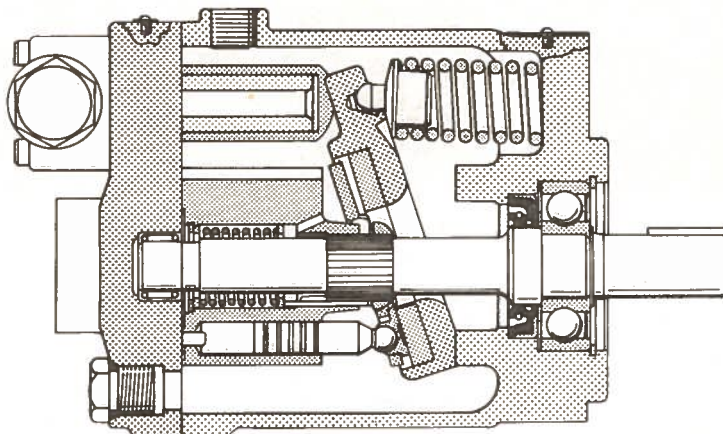
CYL. BLOCK	PIN (3 REQ'D)	WASHER	SPHER. WASHER	SHOE PLATE	PISTON S/A KIT	SWASH PLATE	ROTATING GROUP KIT
THESE PARTS INCLUDED IN							
274670					942229	319245	938262
316000	248203	274956	275485	274249			938265
315148					942230		938264

F3 EQUIVALENT
SEAL KIT 919308

PISTON S/A KIT
INCLUDES 9
PISTON S/A

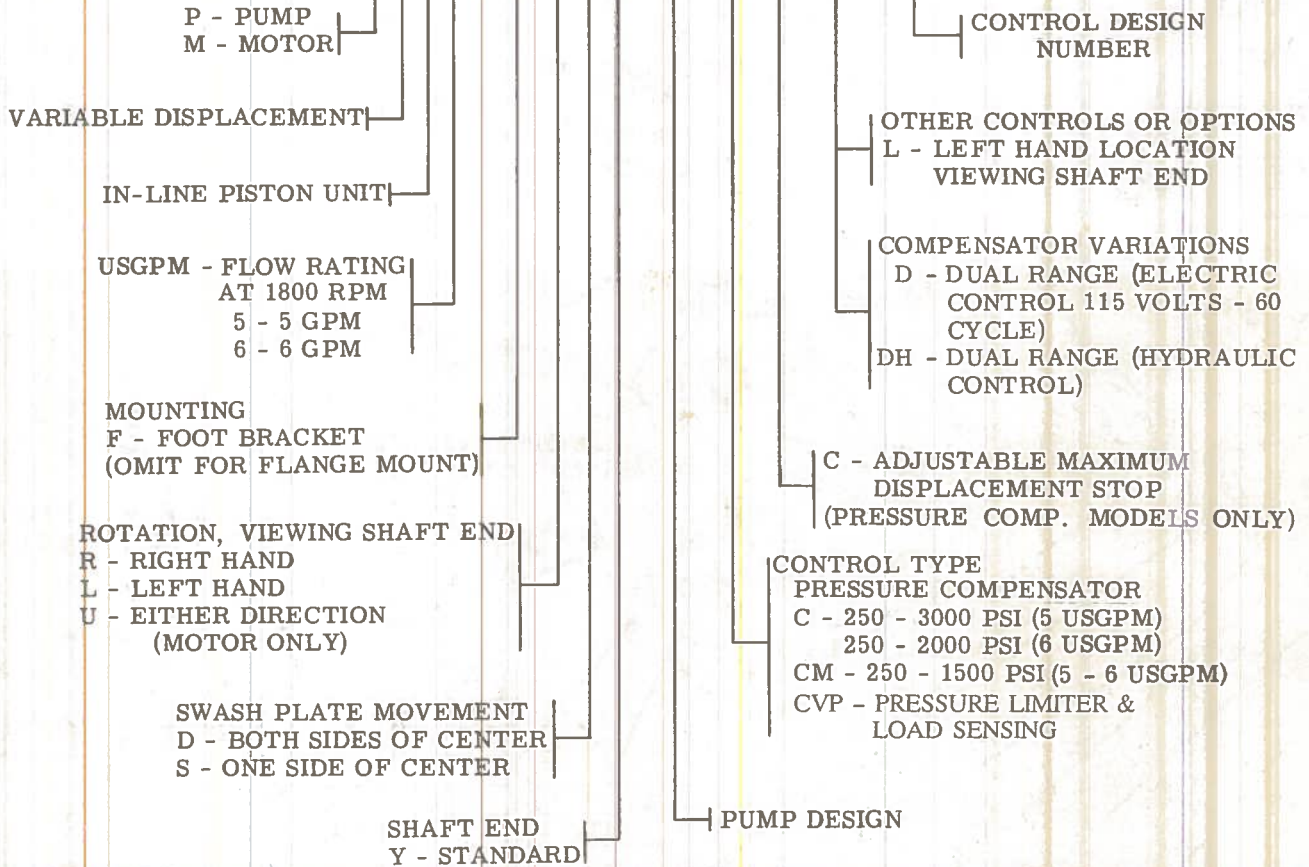
*USED WITH COMPENSATOR
CONTROL ONLY

ΔINCLUDED IN
919191 SEAL KIT

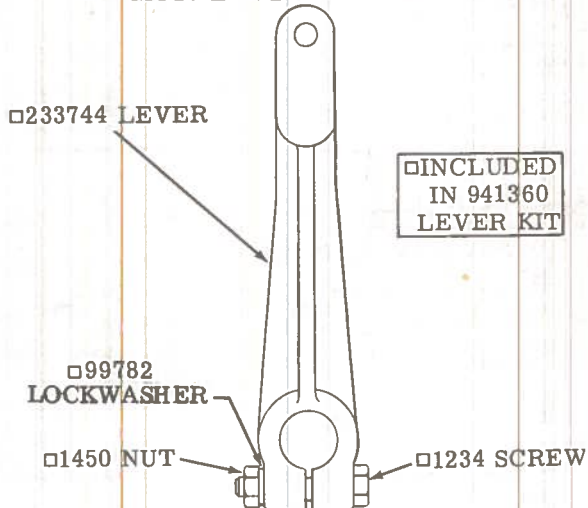


MODEL CODE BREAKDOWN

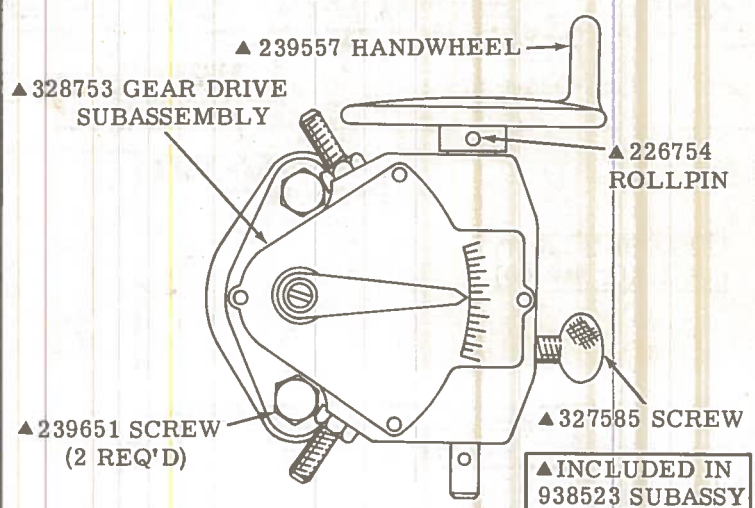
VB - (F) * * Y - 20 - * (*) (*) - 1 *



MANUAL LEVER CONTROL
MODEL *VB*-*-20-M-10



HANDWHEEL CONTROL
MODEL *VB*-*-20-H-10



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

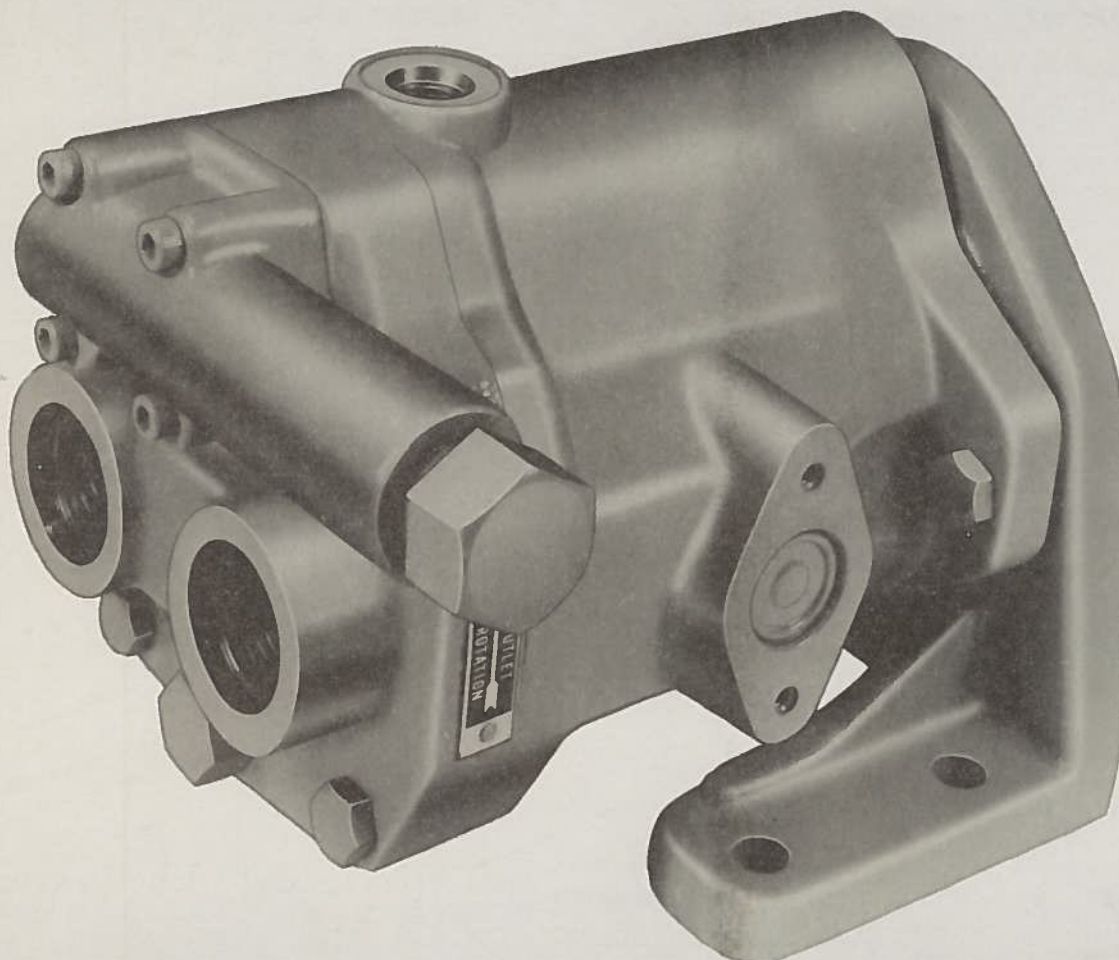
Service Parts Information

Variable In-Line Piston Units

PVB10-(F)**(Y)-30/31-*(*) (L)-1*

PVB15-(F)**(Y)-30/31-*(*) (L)-1*

MPVB10-(F)VD(Y)-30/31-**-10



Vickers, Incorporated

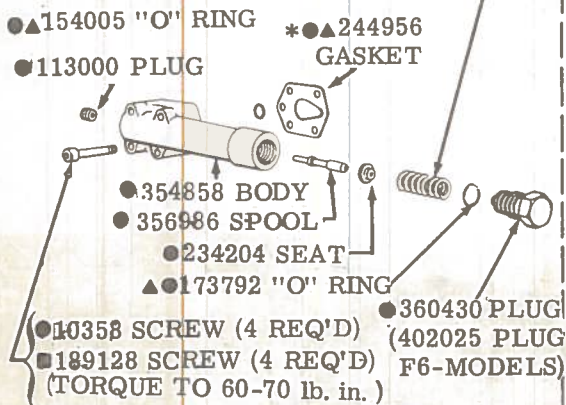
P.O. Box 302
Troy, Michigan 48007-0302

Revised 12-1-87

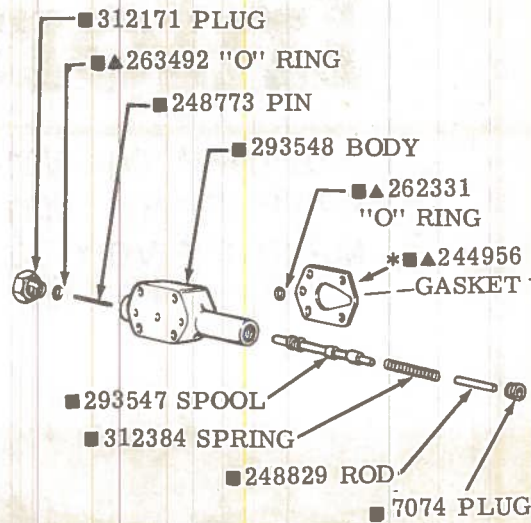
I-3268-S

NOTE
COMPENSATOR S/A PARTS
SHOWN WITHIN THIS AREA.

PRESSURE RANGE (PSI)	COMPEN- SATOR SUBASSY	SPRING
(C) 350-3000 (10)	942158	239371
350-2000 (15)		
(CM) 350-1500	942159	● 265693

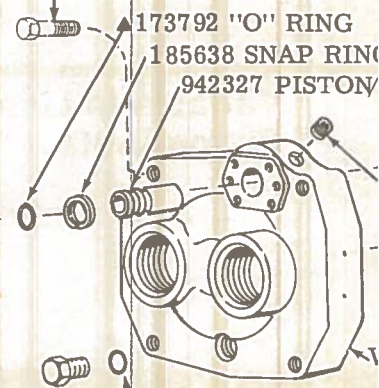


■ INCLUDED IN START-UP VALVE (E) SUBASSY 942157



■ INCLUDED IN START-UP VALVE SUBASSY 942157.

1276 SCREW (4 REQ'D)
(TORQUE TO 25-35 lb. ft.)

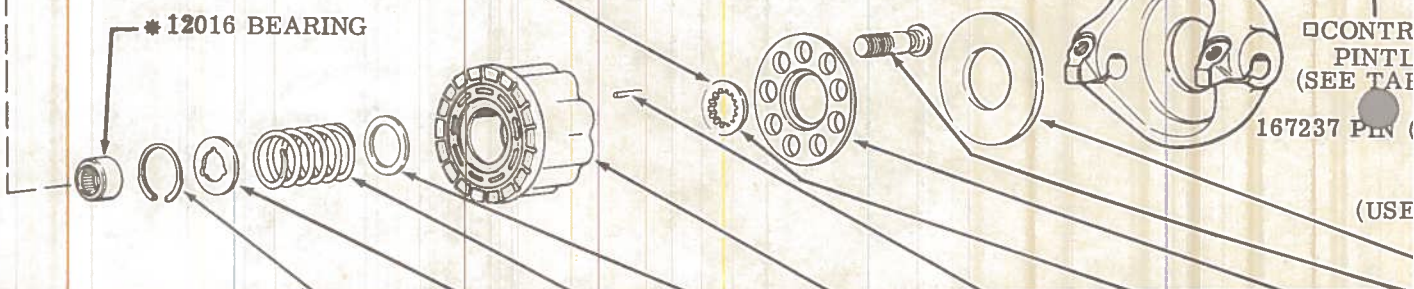


YOKE	HOUSING
325689	308227
342743	35052
325689	308327
342743	398719

IMPORTANT: COMPENSATOR AND START-UP VALVE SHOWN FOR L. H. SHAFT ROTATION. FOR R. H. ROTATION UNITS, ROTATE BOTH VALVES 180°.

CAUTION
DO NOT USE BACK-UP WASHER WITH NEW SPHERICAL WASHER.

1306 SCREW (2 REQ'D)
(TORQUE TO 75-80 lb. ft.)



MODEL	RETAINING RING	WASHER	SPRING	THRUST WASHER	CYLINDER BLOCK	PIN (3 REQ'D)	SPHERICAL WASHER	SHOE PLATE	PISTON S/A			
	THESE PARTS INCLUDED IN											
PVB10-**(Y)-3*-**-1*	93509	245223	247294	241954	321703	248812	423324	275961	9420			
MVB10-**(Y)-3*-**-1*					260860				9418			
PVB15-**(Y)-3*-**-1*												
F6-PVB15-**(Y)-3*-**-1*			403858									

● PARTS INCLUDED IN COMPENSATOR S/A.

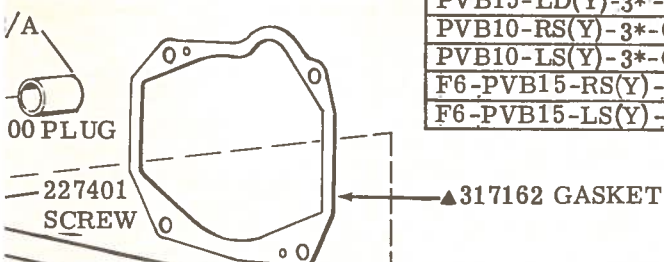
NOTE: TYPE 'C' & 'CM' COMPENSATOR CONTROL PARTS SHOWN. SEE BACK PAGE FOR MANUAL CONTROLS. REFER TO PARTS DRAWING I-3243-S FOR 'CVP' PRESSURE LIMITING & LOAD SENSING COMPENSATOR CONTROL.

MODELS	PINTLES	
	CONTROL	OTHER
HANDWHEEL	269657	265425
LEVER	269658	
COMPENSATOR	265425	

INCLUDED IN
VALVE PLATE S/A

MODEL	*INCLUDED IN VALVE PLATE SUBASSY
PVB10-RD(Y)-3*-H/M-10	942160
PVB10-LD(Y)-3*-H/M-10	942161
MVB10-UD(Y)-3*-H/M-10	942162
PVB15-RD(Y)-3*-H/M-10	942163
PVB15-LD(Y)-3*-H/M-10	942164
PVB10-RS(Y)-3*-C(*)-11	942165
PVB10-LS(Y)-3*-C(*)-11	942166
F6-PVB15-RS(Y)-3*-C(*)-11	942167
F6-PVB15-LS(Y)-3*-C(*)-11	942168

***NOTE**
POSITION COMPENSATOR GASKET
WITH SMALL END OF TEARDROP
HOLE POINTING IN DIRECTION OF
COMPENSATOR ADJUSTING PLUG.



ROTATION PLATE SHOWN
FOR RIGHT HAND (CW)
SHAFT ROTATION. LO-
CATE ON OPPOSITE SIDE
OF VALVE PLATE FOR
LEFT HAND (CCW) ROTA-
TION.

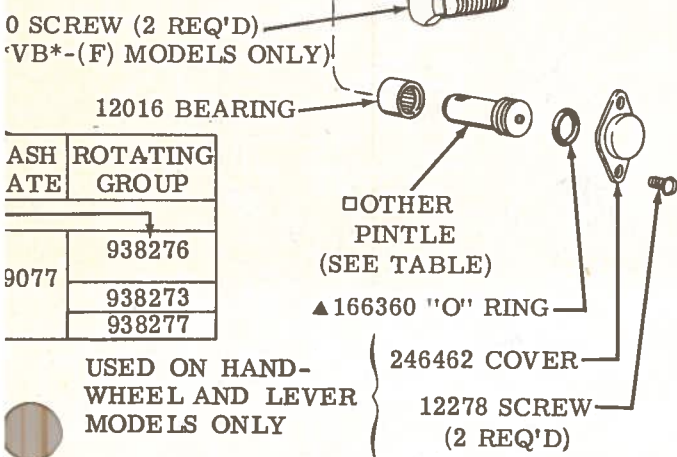
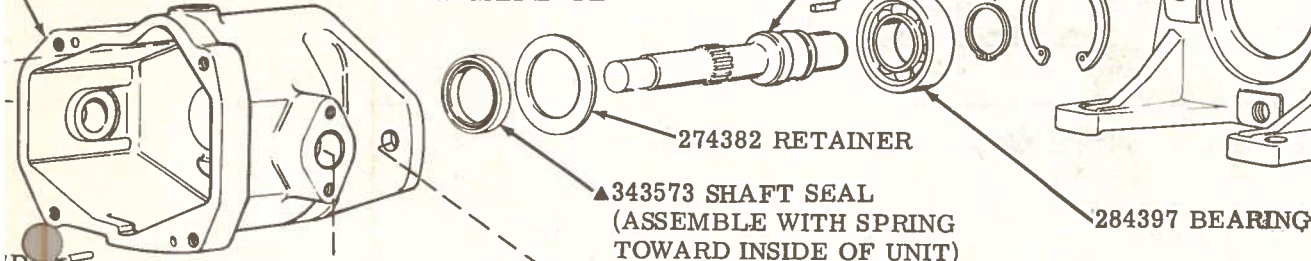
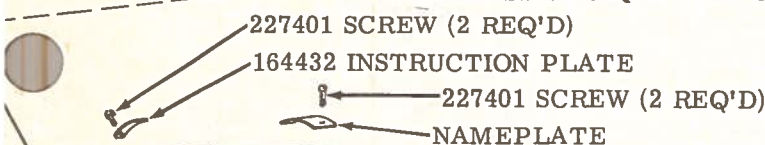
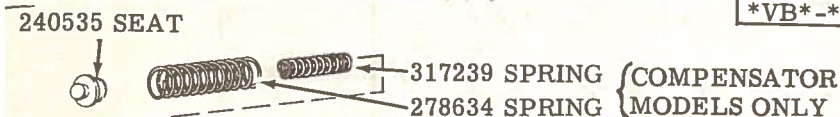
▲INCLUDED IN
919682 SEAL KIT

F3 EQUIVALENT
SEAL KIT 919686

MODEL	SCREW	ROTATION PLATE
1* *D(Y)-3*-H/M-10	227401	195060
1 S(Y)-3*C(*)/CM-11	227407	404751
310-*D(Y)-3*-H/M-10		
PVB15-*S(Y)-3*-C(*)-11	227407	404751

FOOT BRACKET KIT FB-B-10
(USED ON *VB*-(F) MODELS ONLY)
(INCLUDES SCREWS)

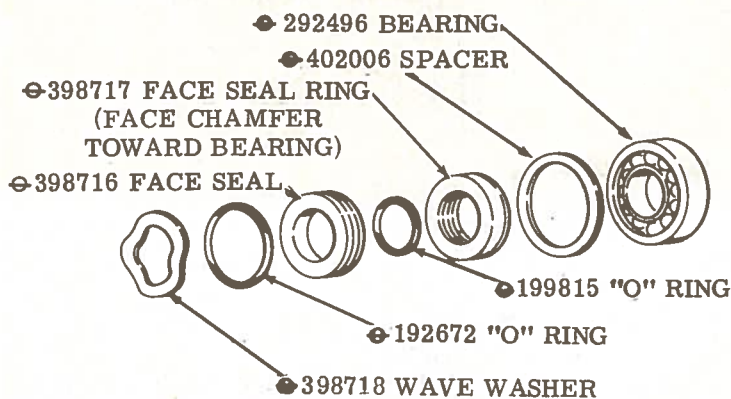
MODEL	SHAFT	KEY
VB-*Y*-3*	261478	22971
VB-*Y*-3*	270369	58303



ASH ATE	ROTATING GROUP
	938276
9077	938273
	938277

USED ON HAND-
WHEEL AND LEVER
MODELS ONLY

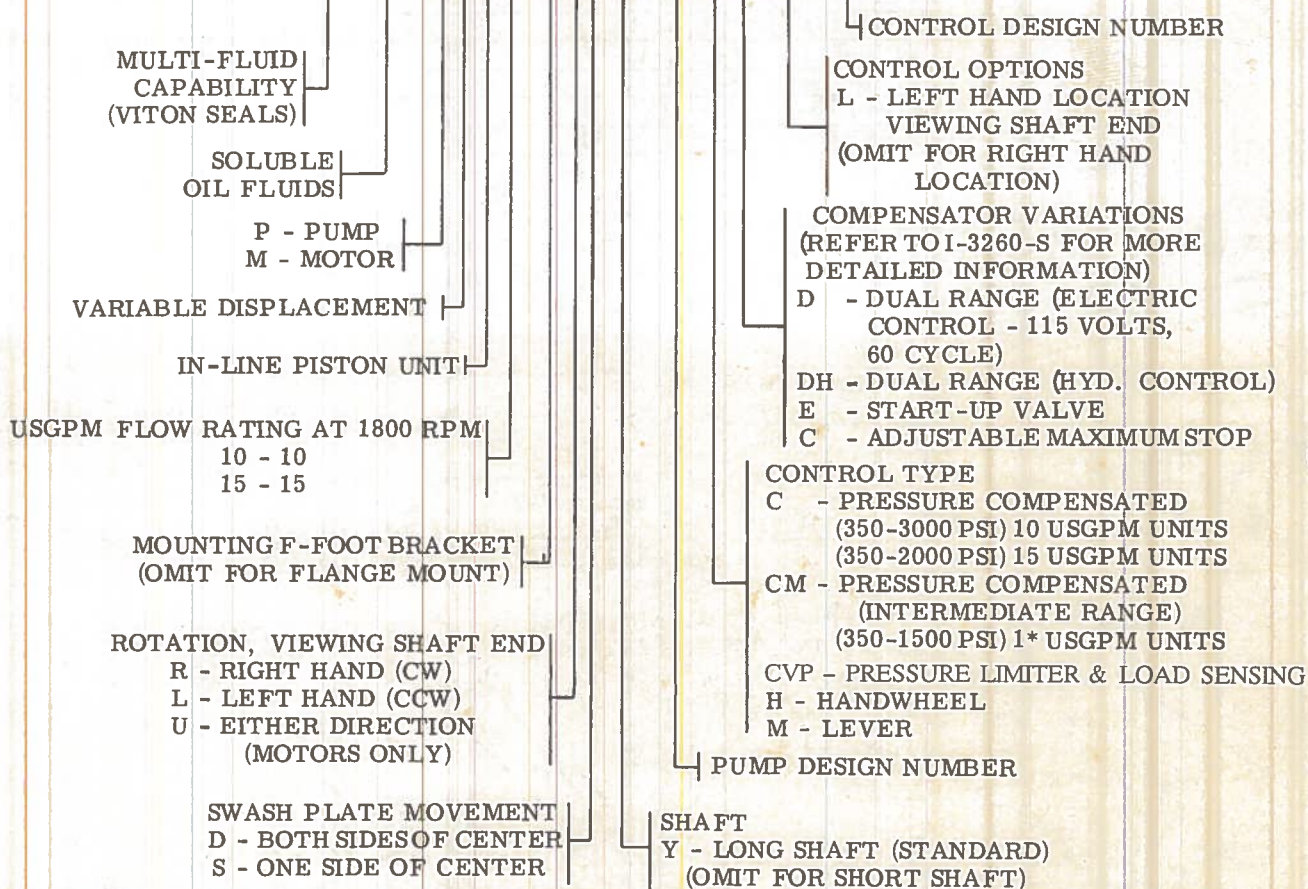
F6 MODEL SHAFT SEAL ARRANGEMENT
(REPLACES SEAL, RETAINER, AND BEARING SHOWN ABOVE.)



INCLUDED IN 920242
SHAFT SEAL KIT

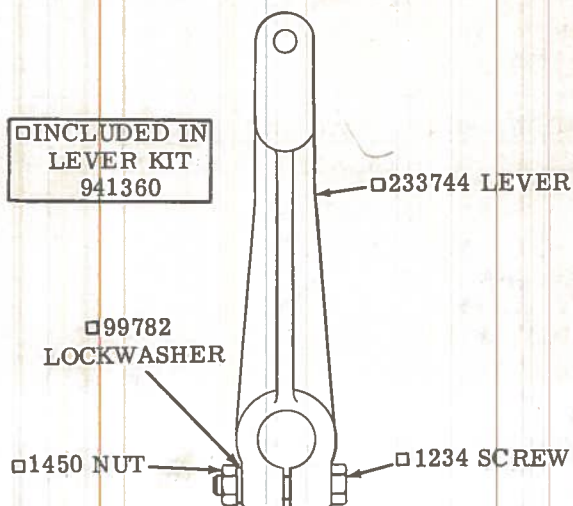
MODEL CODE BREAKDOWN

(F3/F6)-*VB*(-*)**(*)-3*-*(*) (L)-1*



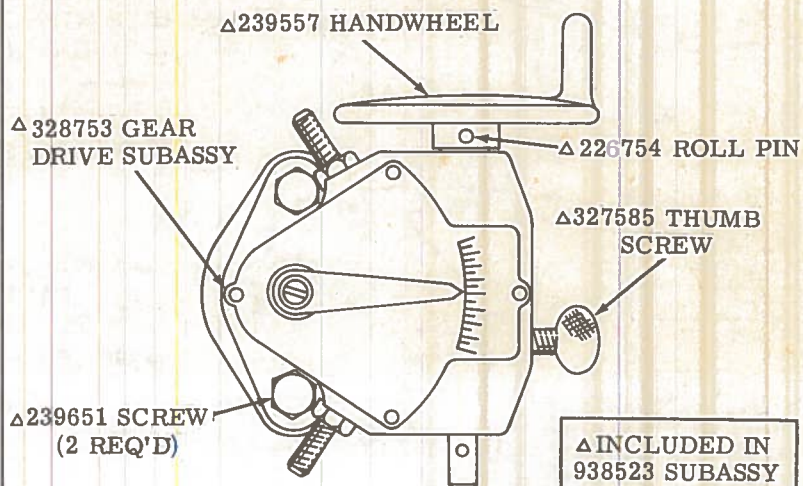
MANUAL LEVER CONTROL MODEL

VB(-*)**(*)-3*-M(*)-10



HANDWHEEL CONTROL MODEL

VB(-*)**(*)-3*-H(*)-10



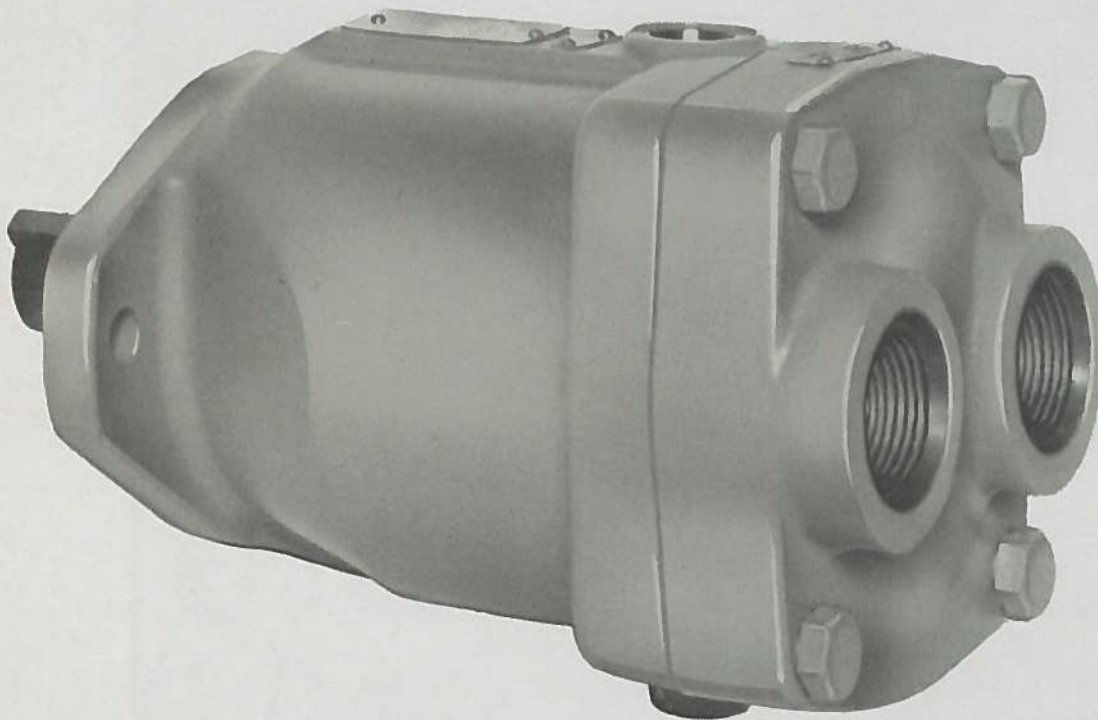
To insure sustained efficiency and maximum trouble free life of this precision equipment, initial and continuous full flow filtration of the fluid medium is essential. Select and apply filters from the Vickers OFF, OFR, and OFRS series, which are available in 3, 10, and 25 micrometre filtration ratings.

Litho in U. S. A.

Service Parts Information

**20 & 29
Fixed
Inline
Piston
Units**

PFB20-(F)*-10
MFB20-(F)U-10
MFB29-(F)U-10



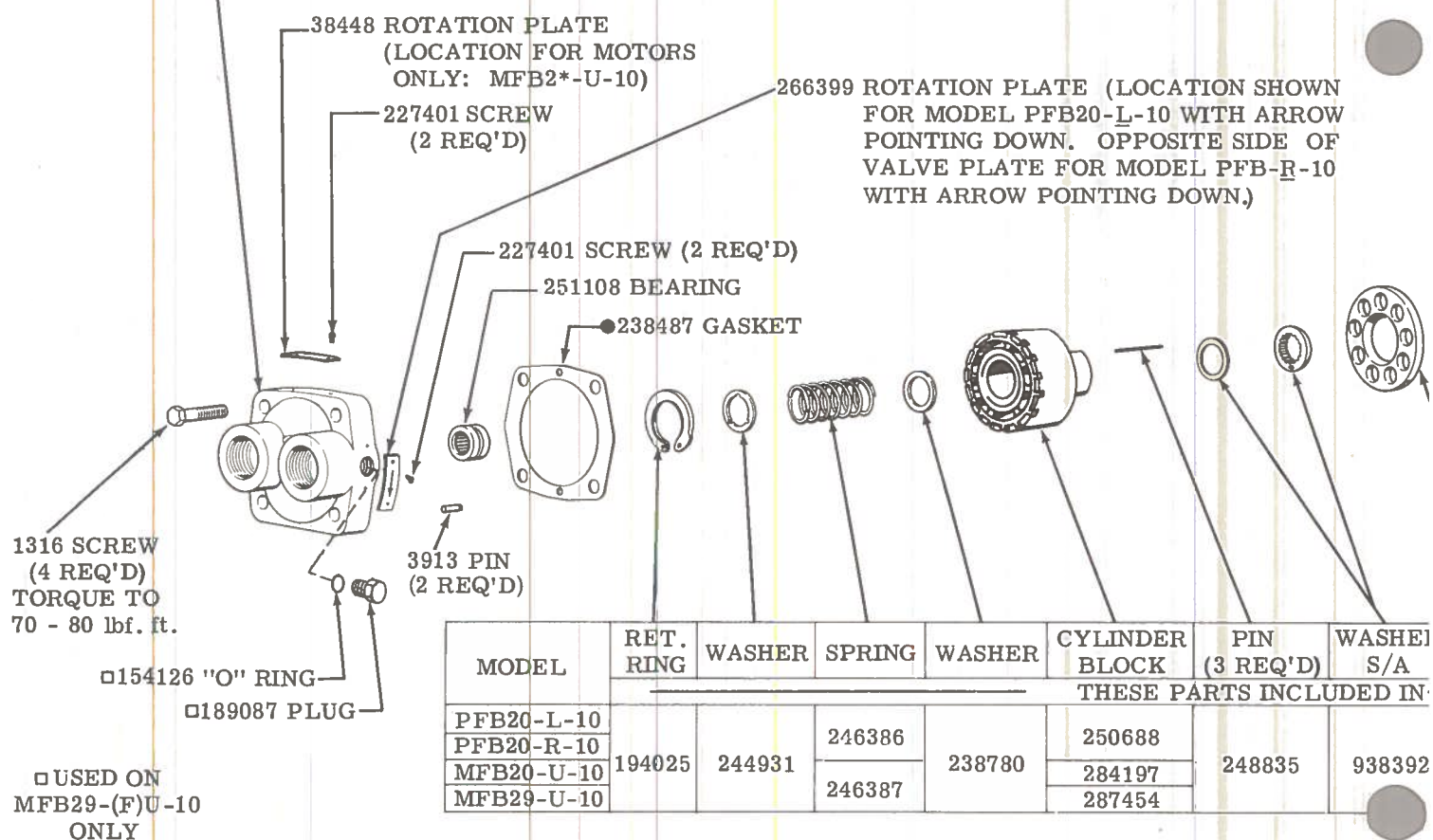
Vickers, Incorporated

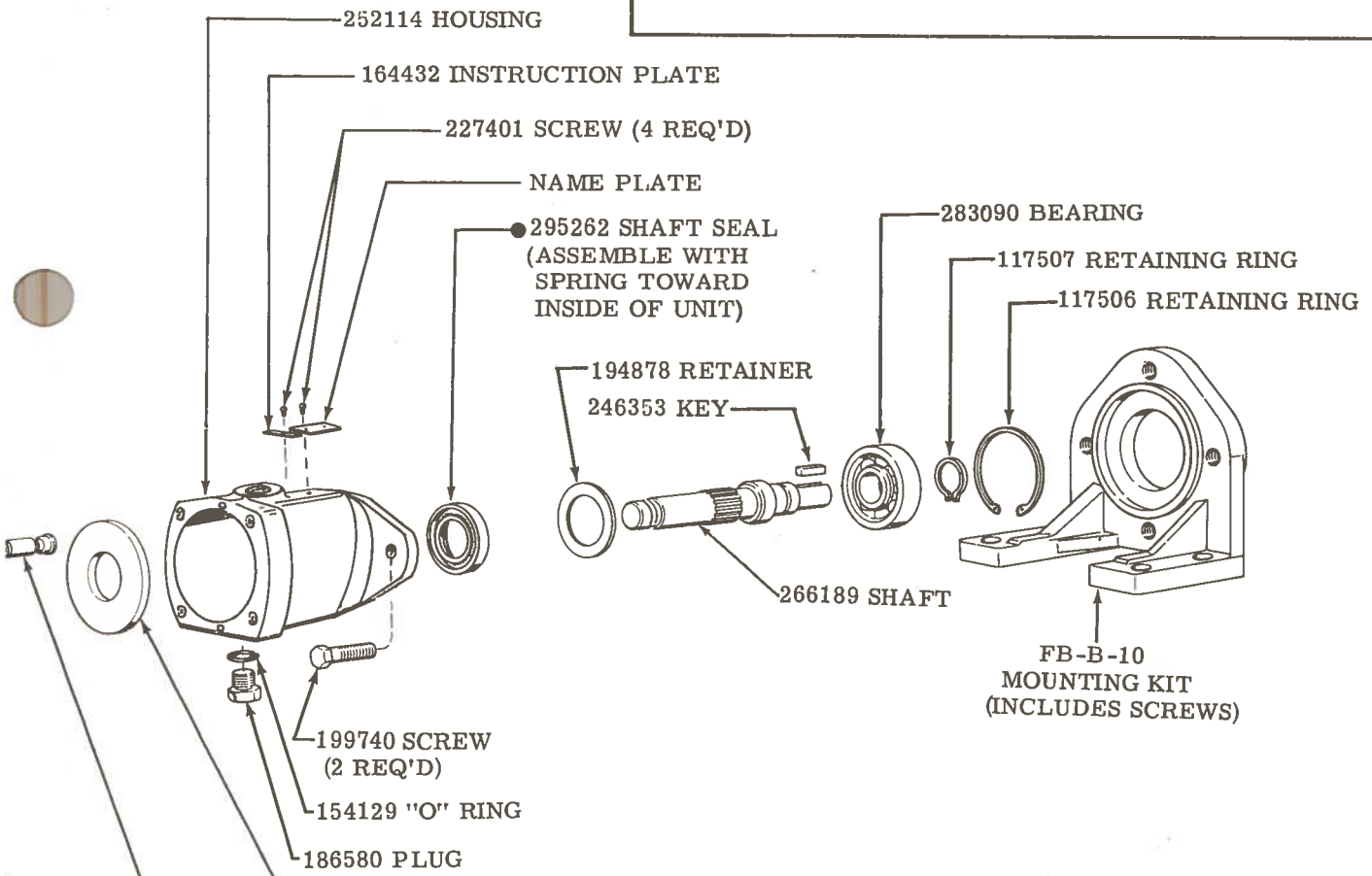
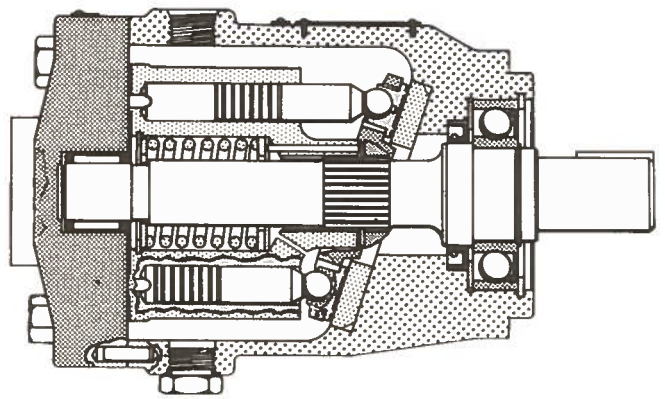
1401 Crooks Road
Troy, Michigan 48064

Revised 10-1-85

I-3247-S

MODEL	VALVE PLATE SUB-ASSY (INCLUDES: ROTATION PLATE & 251108 BEARING)
PFB20-L-10	938382
PFB20-R-10	938381
MFB20-U-10	938383
MFB29-U-10	941952



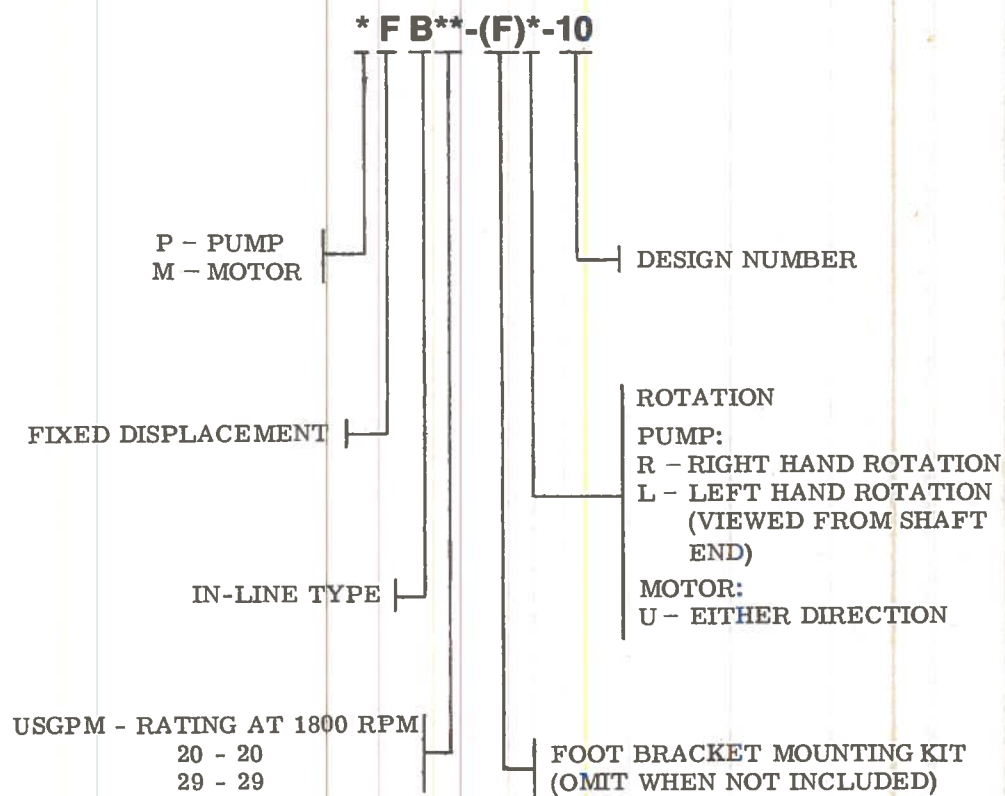


IOE ATE	PISTON S/A KIT	SWASH PLATE	ROTATING GROUP KIT
3609	941883	239335	938280
	941884		938281
	941885		938295

● INCLUDED IN
919242 SEAL KIT

F3 EQUIVALENT
SEAL KIT 919313

MODEL CODE BREAKDOWN



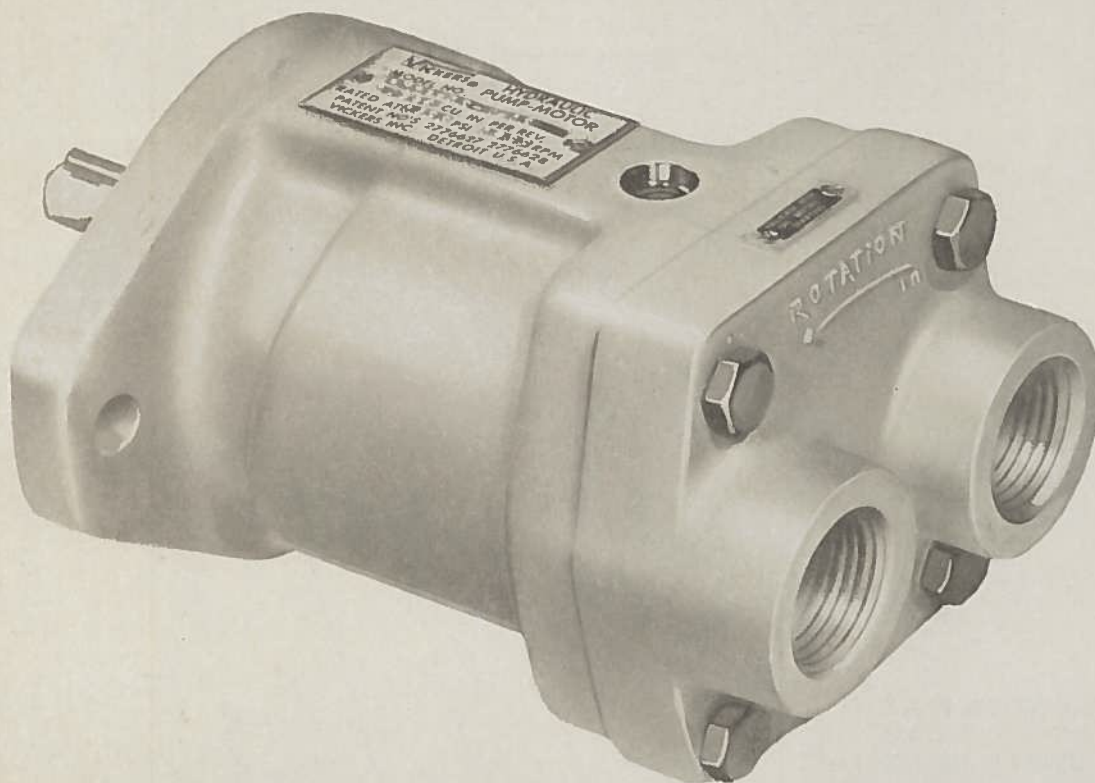
For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Service Parts Information

**5 GPM
Fixed Inline
Piston Units**

PFB5-(F)R(Y)-21
PFB5-(F)L(Y)-21
(M) *FB5-(F)U(Y)-11/20
PMFB5-(F)U-10



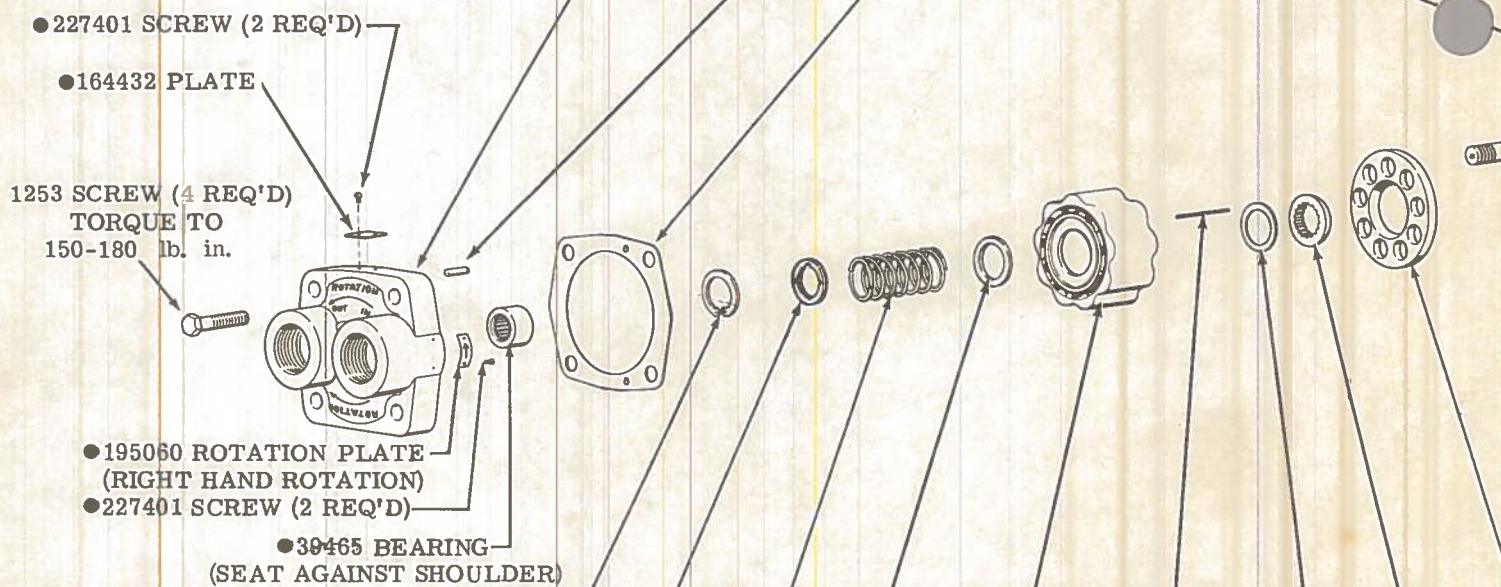
Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 10-1-85

I-3238-S

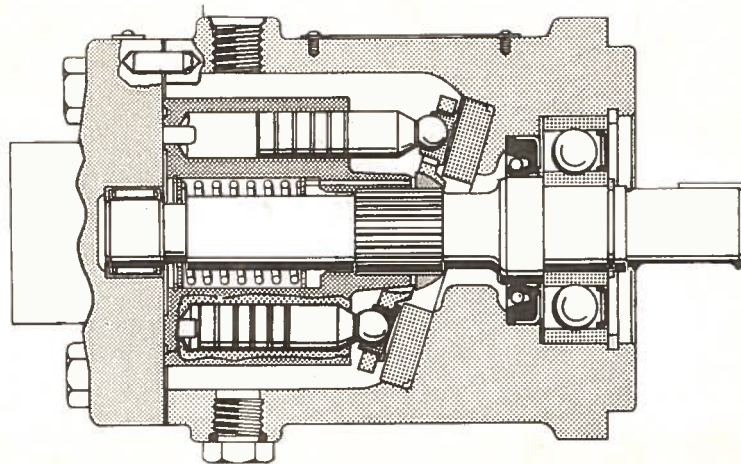
MODEL	● VALVE PLATE S/A	PIN (2 REQ'D)	GASKET	HOUSING
PMFB5-U-10	—	12987	▲231643	231559
*FB5-(F)U(Y)-11	938551	167237	▲279614	274668
FB-(F)U(Y)-20	942313			323951
PFB5-(F)R(Y)-21	942314			
PFB5-(F)L(Y)-21	942314			



MODEL	RET. RING	LIFT LIMITER	SPRING	WASHER	CYLINDER BLOCK	PIN (3 REQ'D)	WASHER	WASHER	PL
PMFB5-U-10	165385	—	—	—	—	—	—	—	—
PFB5-(F)U(Y)-11/20/21		273409	274787	275474	274670	248203	274956	275485	27.
(M)-MFB5-(F)U(Y)-11/20			—	—	316000	—	—	—	—
M-MFB6-**-20			272015	—	290059	—	—	—	—

● INCLUDED IN
VALVE PLATE S/A

THESE PARTS ARE INCLUDED IN ROTATING GROUP



▲ 237014 SEAL
ASSEMBLY WITH SPRING
TOWARD INSIDE OF UNIT

190362 WASHER
USED ONLY ON
*FB5-(F)U(Y)-11/20/21

283233 BEARING

93653 RETAINING RING

140356 RETAINING RING

FB-A-10
(INCLUDES SCREWS)

177939 SCREW (2 REQ'D)
(P)*FB5-F**-** ONLY

MODEL	PLUG	"O" RING
*FB5-(F)U(Y)-10/11	189087	▲154126
FB5-(F)U(Y)-2	181728	▲154128
PFB5-*R/L*-21		

MODEL	SHAFT	KEY
FB5-U-11/2	274669	157671
*FB5-UY-11/20	266161	142843
PFB5-*R/L*-21	#274669	157671
PMFB5-U-10	295237	
M-MFB*-*G-20		

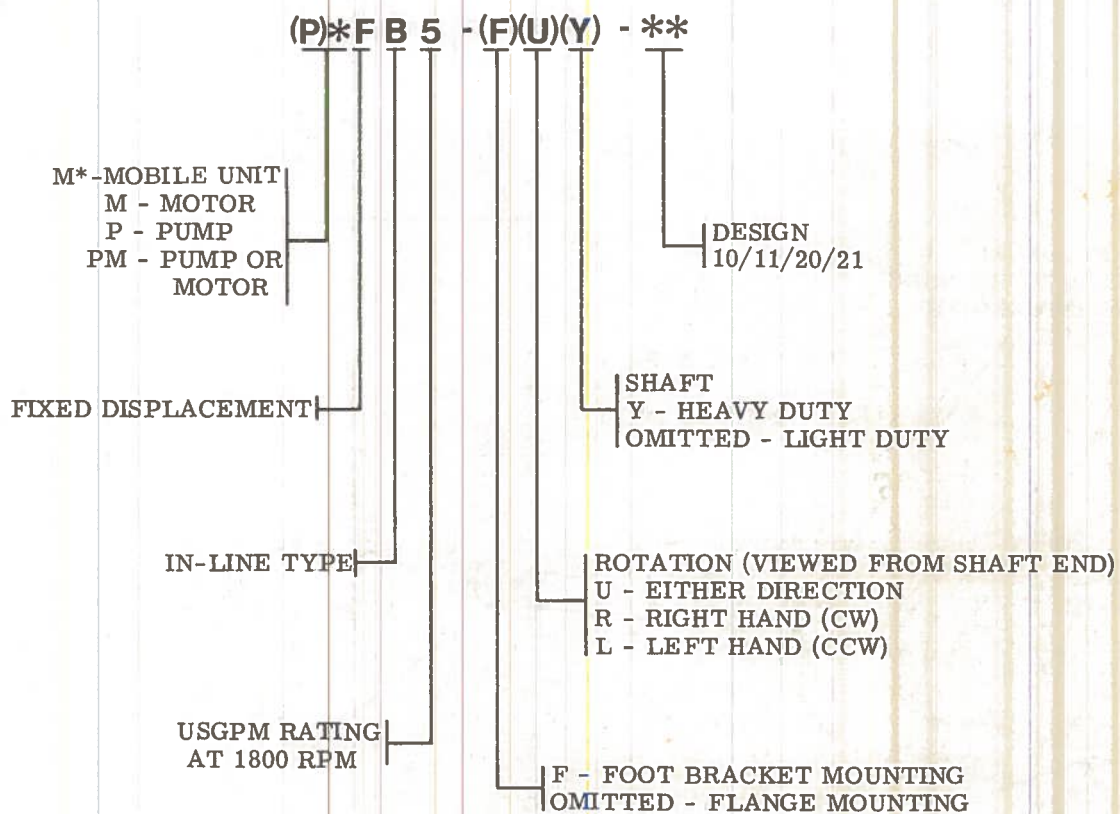
PISTON S/A KIT	SWASH PLATE	ROTATING GROUP KIT
		938260
942229	319245	938262
		938265
942350	344049	922994

F3 EQUIVALENT
SEAL KIT 919311

▲ INCLUDED IN
919239 SEAL KIT

#WHEN ORDERING THIS SHAFT, ALSO
ORDER 273409 LIFT LIMITER

MODEL CODE BREAKDOWN



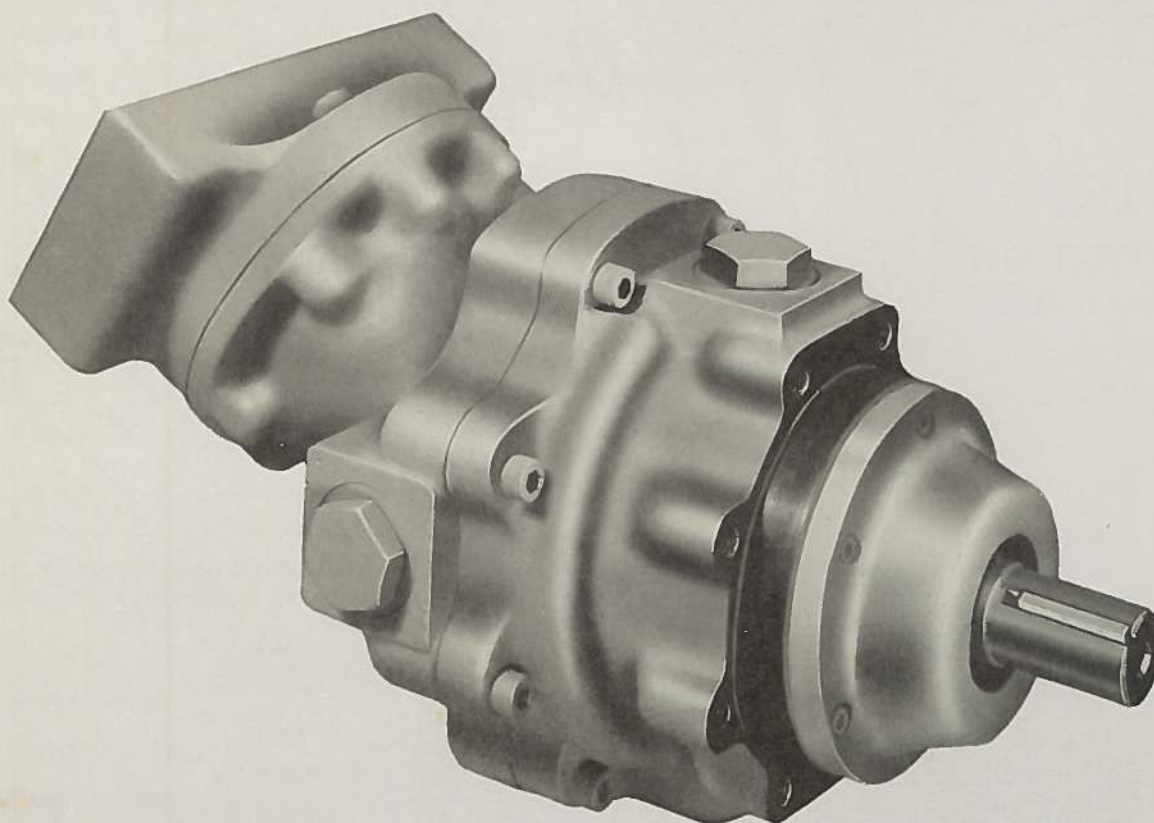
For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Service Parts Information

**Fixed Angle
Piston Type
Pumps &
Motors**

PFA150-**-F)*-14
MFA150-**-F)*-14

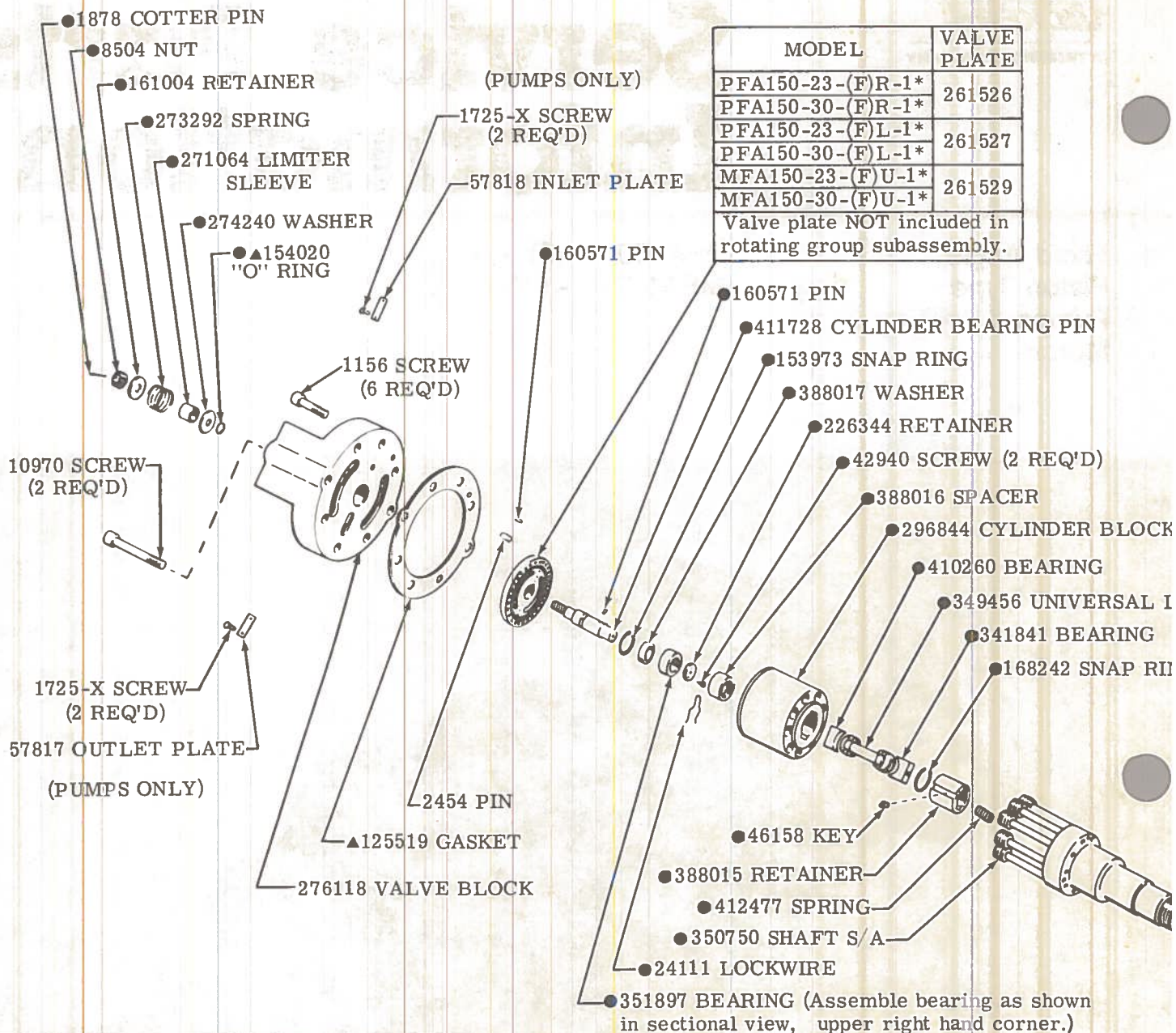


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Revised 10-1-85

I-3225-S



MODEL	VALVE PLATE
PFA150-23-(F)R-1*	261526
PFA150-30-(F)R-1*	
PFA150-23-(F)L-1*	261527
PFA150-30-(F)L-1*	
MFA150-23-(F)U-1*	261529
MFA150-30-(F)U-1*	
Valve plate NOT included in rotating group subassembly.	

CONNECTION FLANGE MODEL NUMBERS		PIPING SIZE	FLANGE DESIGN
WELDED	THREADED		
FL-20-WS-20	FL-20-PS-20	2-1/2"	STRAIGHT
FL-20-WL-20	FL-20-PL-20	2-1/2"	ELL
FL-24-WS-20	FL-24-PS-20	3"	STRAIGHT
FL-24-WL-30	FL-24-PL-20	3"	ELL
FLANGE ASSEMBLY INCLUDES: FLANGE (1), "O" RING (1), SCREWS (4) AND WASHERS (4)			
Flanges tabulated above are rated for 3000 PSI. Straight flanges with SAE Grade 8 screws for use to 5000 PSI can be supplied. Specify by adding "HP" to model number. Example: FL-20-WS-HP-20 Torque "HP" flange screws to 175-200 lb. ft.			

MODEL	ANGLE HOUSING
PFA150-23-(F)R-1*	249839
PFA150-23-(F)L-1*	
MFA150-23-(F)U-1*	
PFA150-30-(F)R-1*	237237
PFA150-30-(F)L-1*	
MFA150-30-(F)U-1*	

▲ INCLUDED IN
919189 SEAL KIT

● INCLUDED IN 938071
ROTATING GROUP

8504 NUT

297474 BEARING
RETAINER
NUT

VERY IMPORTANT

To provide proper running clearance of cylinder block, tighten 8504 nut so valve block, valve plate and cylinder block are clamped snugly together. Then turn the nut off from 1/6 to 1/4 turn to align the slot with the key hole in the pin.

VERY IMPORTANT

To insure proper running clearance of front and

rear bearings, tighten nut 297474 so drive shaft sub-assembly and front bearing are clamped snugly together. Then back off nut until there is .003 to .005 clearance between nut and bearing. Insert screw 1076 in nut and tighten. Recheck clearance. Tap end of shaft until nut is flush with front bearing.

DRAIN CONNECTION INSTRUCTIONS

Any one of three drain connections may be used. A full size unrestricted case drain line must be connected from the drain port directly to reservoir in such a manner that the housing remains filled with fluid. Drain line loop must extend above top of case to prevent syphoning action.

181822 PLUG (2 REQ'D)
154133 SEAL (2 REQ'D) For unused drain ports.

PIN

235676 KEY

ANGLE HOUSING (SEE TABLE)

237712 GASKET

212887 BEARING

237238 HOUSING

297472 SEAL (ROTOR)

262411 "O" RING

297473 SEAL (STATOR)

262419 "O" RING

226035 GASKET

297475 SEAL RETAINER

1050 SCREW (8 REQ'D)

1173 SCREW
(8 REQ'D)

231069 PIN

297634 SPRING

297474 BEARING
RETAINER NUT

1076 SCREW

220602 BEARING

226078 MOUNTING

USED ON BRACKET
MOUNTED MODELS
*FA-***-F*-1*

7075 PLUG

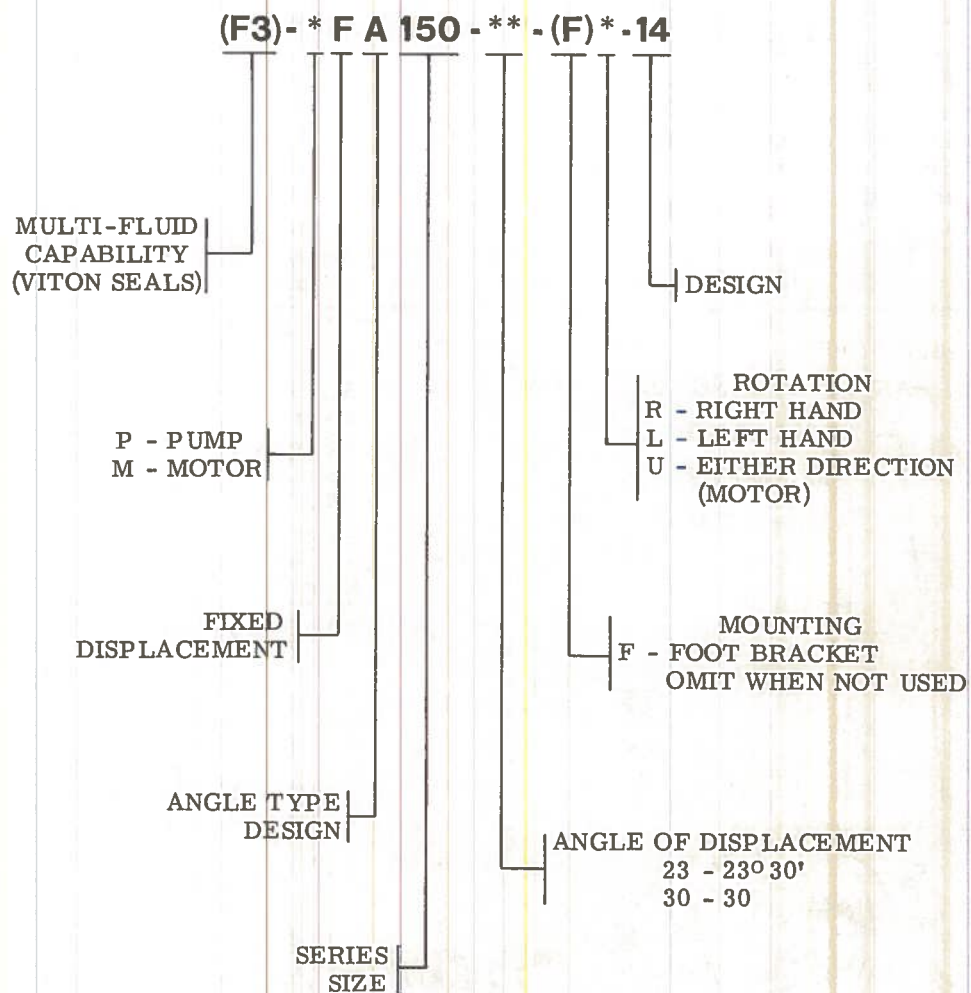
3X-36212 SCREW
(2 REQ'D)

23746 ROTATION
PLATE

1155 SCREW (8 REQ'D)

EBOLT
(MPS ONLY)

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

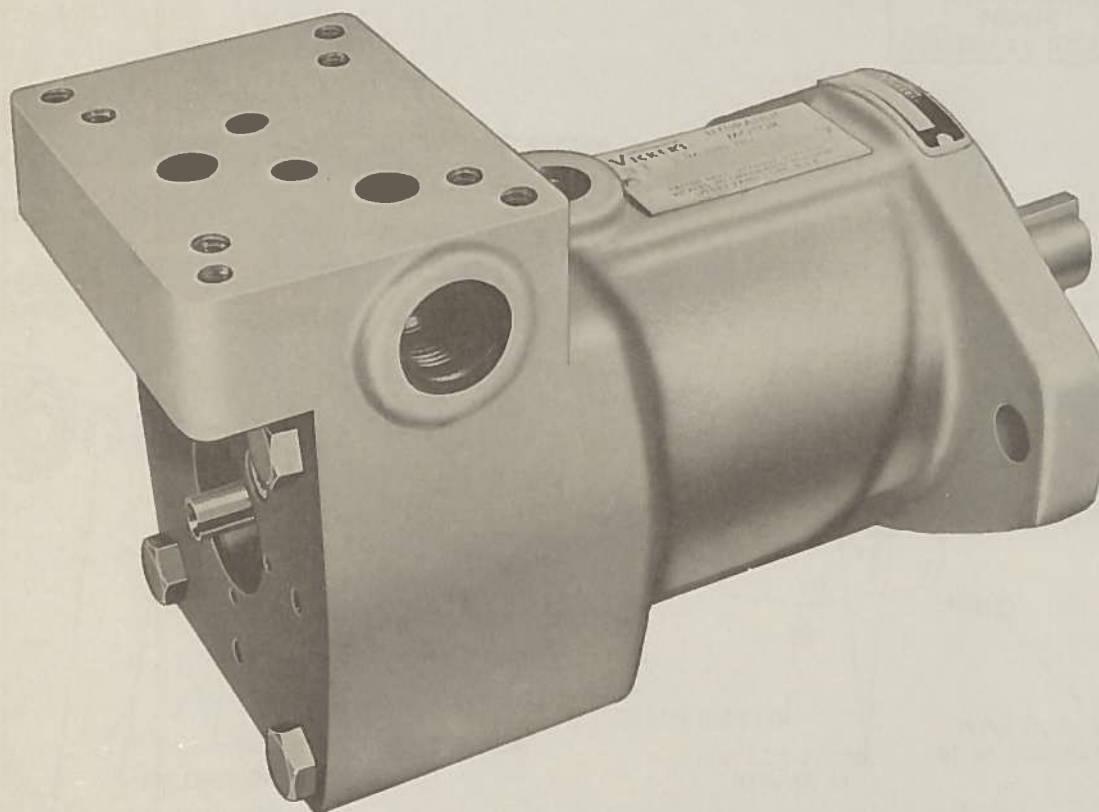
Litho in U. S. A.

VICKERS

Service Parts Information

**5 GPM
Fixed
Inline
Piston
Units**

MFB5-FU-20-S61



Vickers, Incorporated

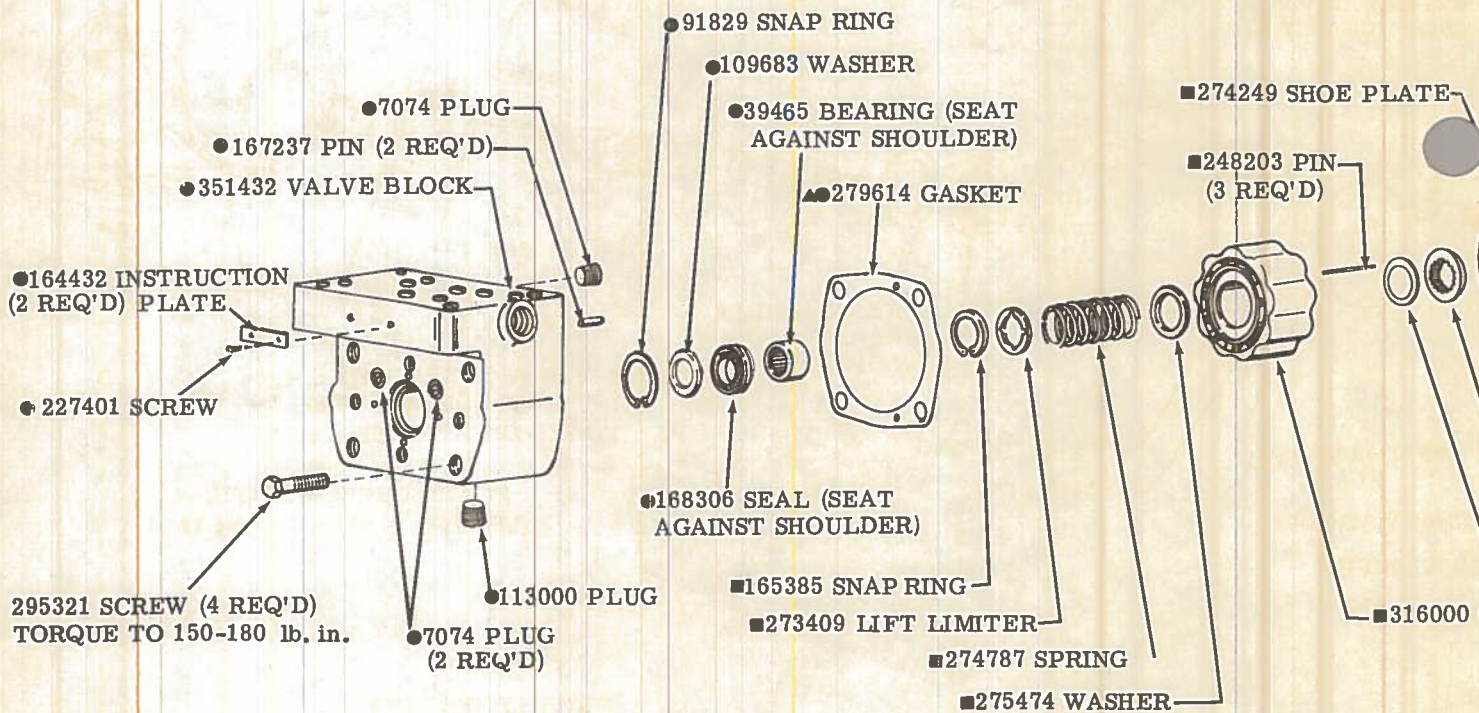
1401 Crooks Road
Troy, Michigan 48064

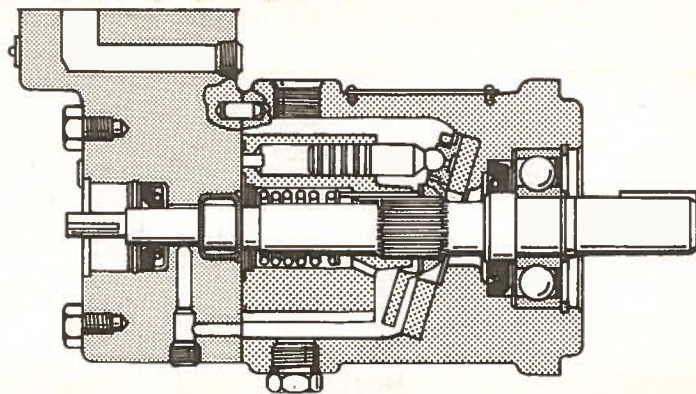
Revised 11-1-85

I-3224-S

A Libbey-Owens-Ford Company

●INCLUDED IN
942324
VALVE PLATE S/A





323951 HOUSING

NAMEPLATE

227401 SCREW
(2 REQ'D)

■ 942229 PISTON &
SHOE SUBASSY KIT

142843 KEY

190362 WASHER

98653 RING

140356 RETAINER

▲ 237014 SEAL (ASSEMBLE
WITH SPRING TOWARD
INSIDE OF UNIT)

351433 SHAFT

283233 BEARING

F-B-A-10 BRACKET S/A
(INCLUDES SCREWS)
(USED ON F MODELS ONLY)

■ 319245 SWASH
PLATE

▲ 154128 "O"RING

181728 PLUG

177439 SCREW (2 REQ'D)
(USED ON F MODELS ONLY)

275485 WASHER

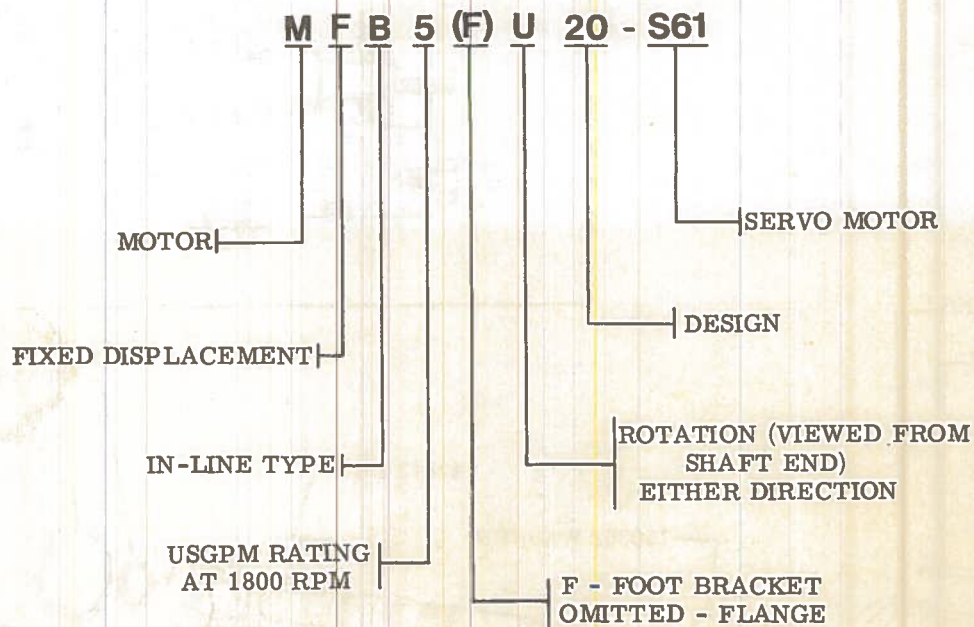
356 WASHER

DER BLOCK

▲ INCLUDED IN
SEAL KIT 919239

■ INCLUDED IN
938265
ROTATING GROUP

MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

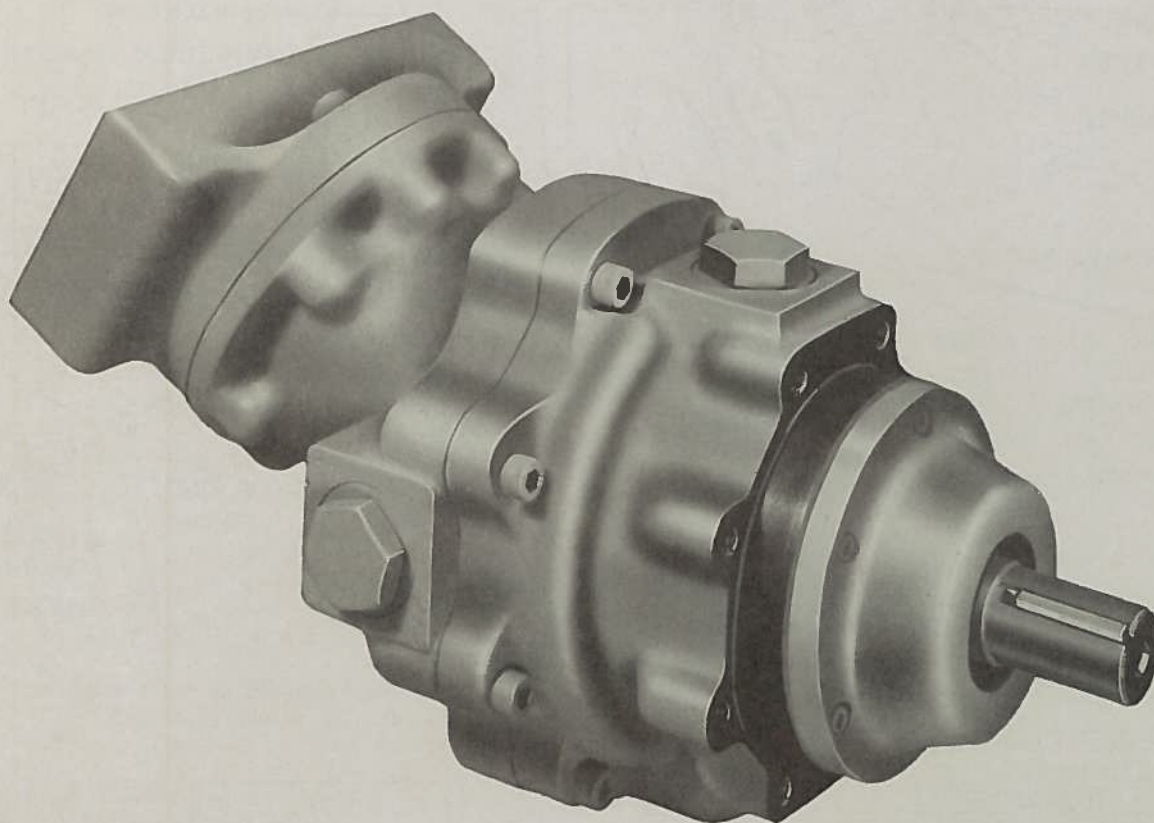
VICKERS®
A TRIMMOVA COMPANY

Service Parts Information

**Fixed
Angle-Piston
Type Pumps
& Motors**

PFA150-**-*(F)*-10/11/12/13

MFA150-**-*(F)*-10/11/12/13

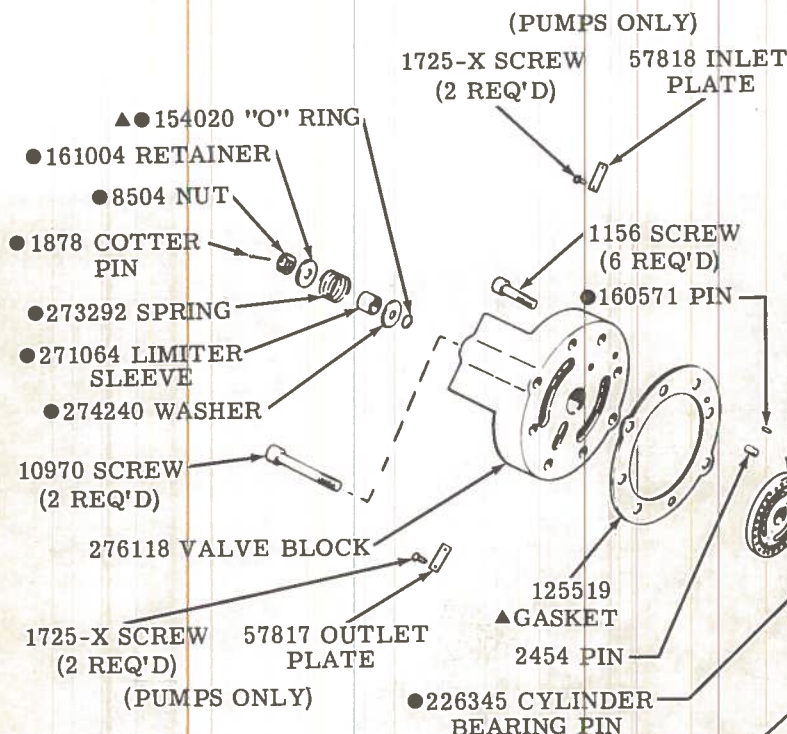


Vickers, Incorporated

1401 Crooks Road
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Revised 9-1-85

I-3222-S



MODEL	VALVE PLATE
PFA150-23-(F)R-1*	261526
PFA150-30-(F)R-1*	261527
PFA150-23-(F)L-1*	261527
PFA150-30-(F)L-1*	261529
MFA150-23-(F)U-1*	261529
MFA150-30-(F)U-1*	261529

Valve plate NOT included in rotating group subassembly.

DESIGN NUMBER	BEARING	UNIVERSAL LINK & PIN	BE
10, 11, 12	220162	220161	2
13	350756	349456	3

NOTE
227705 spacer in -10 design replaced by 292179 spacer and 288391 washer used in -11, -12, and -13 designs.

CONNECTION FLANGE MODEL NUMBERS		PIPING SIZE	FLANGE DESIGN
WELDED	THREADED		
FL-20-WS-20	FL-20-PS-20	2-1/2"	STRAIGHT
FL-20-WL-20	FL-20-PL-20	2-1/2"	ELL
FL-24-WS-20	FL-24-PS-20	3"	STRAIGHT
FL-24-WL-30	FL-24-PL-20	3"	ELL

FLANGE ASSEMBLY INCLUDES: FLANGE (1), "O" RING (1), SCREWS (4) AND WASHERS (4)

Flanges tabulated above are rated for 3000 PSI. Straight flanges with SAE Grade 8 screws for use to 5000 PSI can be supplied. Specify by adding "HP" to model number. Example: FL-20-WS-HP-20. Torque "HP" flange screws to 175-200 lbf. ft.

MODEL	ANGLE HOUSING
PFA150-23-(F)R-1*	249839
PFA150-23-(F)L-1*	249839
MFA150-23-(F)U-1*	249839
PFA150-30-(F)R-1*	237237
PFA150-30-(F)L-1*	237237
MFA150-30-(F)U-1*	237237

▲ INCLUDED IN 919189 GASKET KIT

● INCLUDED IN ROTATING GROUP SUBASSEMBLY

8504 NUT

219136 NUT

1076 SCREW

VERY IMPORTANT

To provide proper running clearance of cylinder block, tighten 8504 nut so valve block, valve plate and cylinder block are clamped snugly together. Then turn the nut off from 1/6 to 1/4 turn to align the slot with the key hole in the pin.

VERY IMPORTANT

To insure proper running clearance of front and rear bearings, tighten nut 219136 so drive shaft sub-assembly and front bearing are clamped snugly together. Then back off nut until there is .003 to .005 clearance between nut and bearing. Insert screw 1076 in nut and tighten. Recheck clearance. Tap end of shaft until nut is flush with front bearing.

RETAINER	SHAFT SUB-ASSY	ROTATING GROUP
220163	*255145	938071
341842	350750	938071

DRAIN CONNECTION INSTRUCTIONS

Any one of three drain connections may be used. A full size unrestricted case drain line must be connected from the drain port directly to reservoir in such a manner that the housing remains filled with fluid. Drain line loop must extend above top of case to prevent syphoning action.

181822 PLUG (2 REQ'D) For unused drain ports
▲154133 SEAL (2 REQ'D)

*NOTE

IF A NEW SHAFT AND PISTON SUBASSEMBLY IS REQUIRED USE -13 DESIGN ROTATING GROUP

●212887 BEARING

●235676 KEY

▲237712 GASKET

237238 HOUSING

●219136 BEARING RETAINER NUT

▲296845 SEAL

▲226035 GASKET

226043 SEAL RETAINER

1050 SCREW (8 REQ'D)

202977 DOWEL PIN

7075 PLUG

●1076 SCREW

●220602 BEARING

1155 SCREW (8 REQ'D)

3X-36212 SCREW (2 REQ'D)

23746 ROTATION PLATE

(PUMPS ONLY)

79997 EYE BOLT

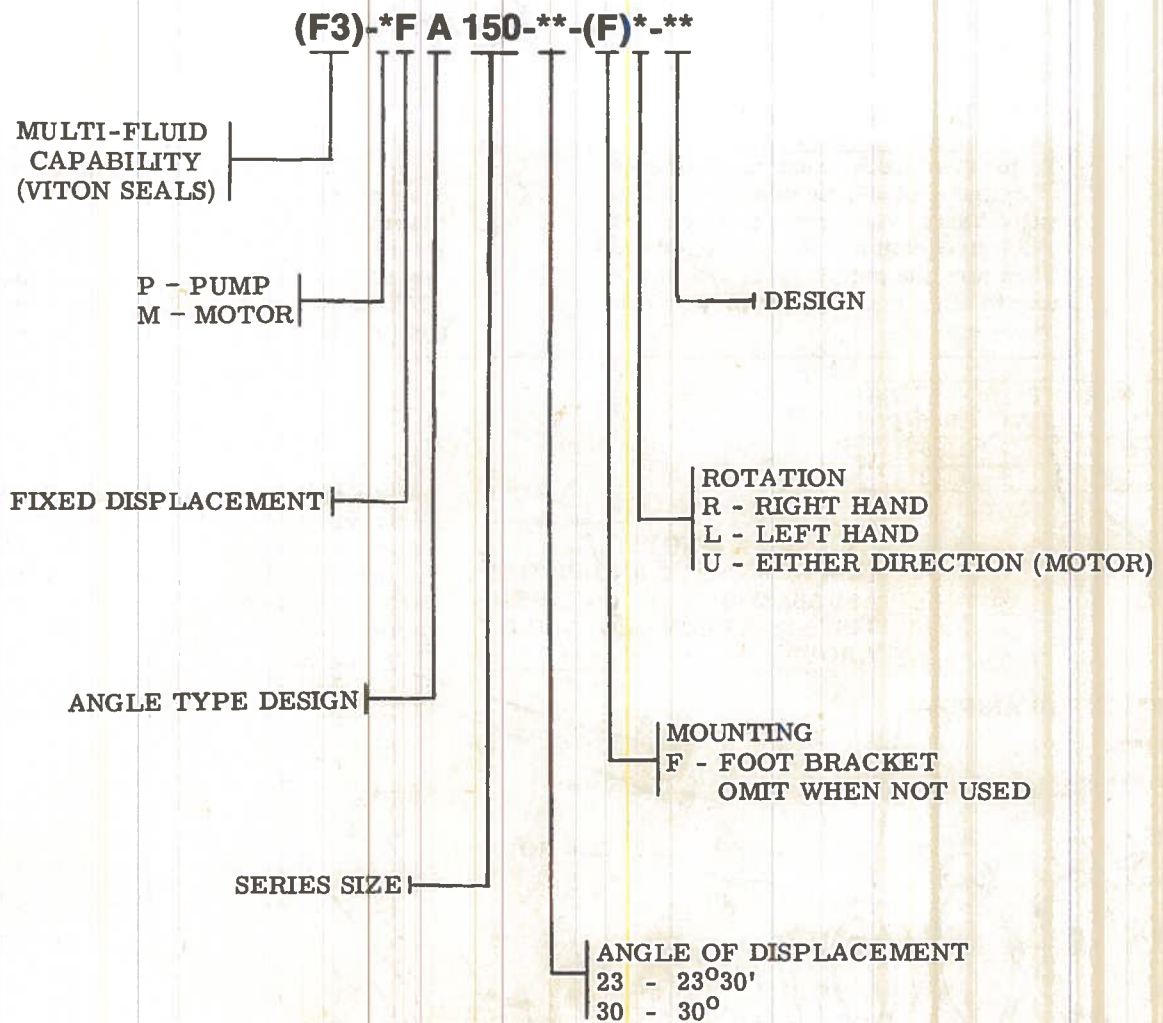
226078 MOUNTING

1173 SCREW (8 REQ'D)

USED ONLY ON BRACKET MOUNTED MODELS

*FA-****-F-1*

MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

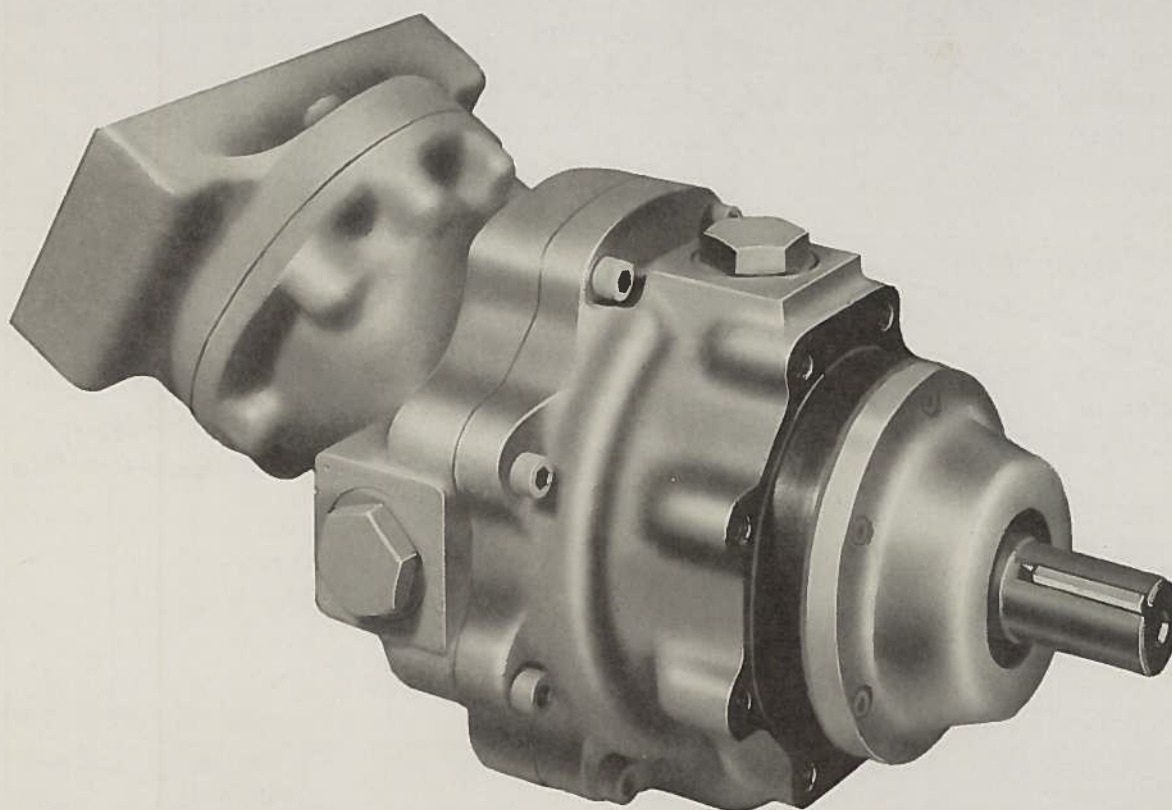
Litho in U. S. A.

VICKERS®
A TRIMMOVA COMPANY

Service Parts Information

**Fixed Angle
Piston Type
Pumps &
Motors**

PFA120-**-*(F)*-10/11/12/13/14
MFA120-**-*(F)*-10/11/12/13/14



Vickers, Incorporated

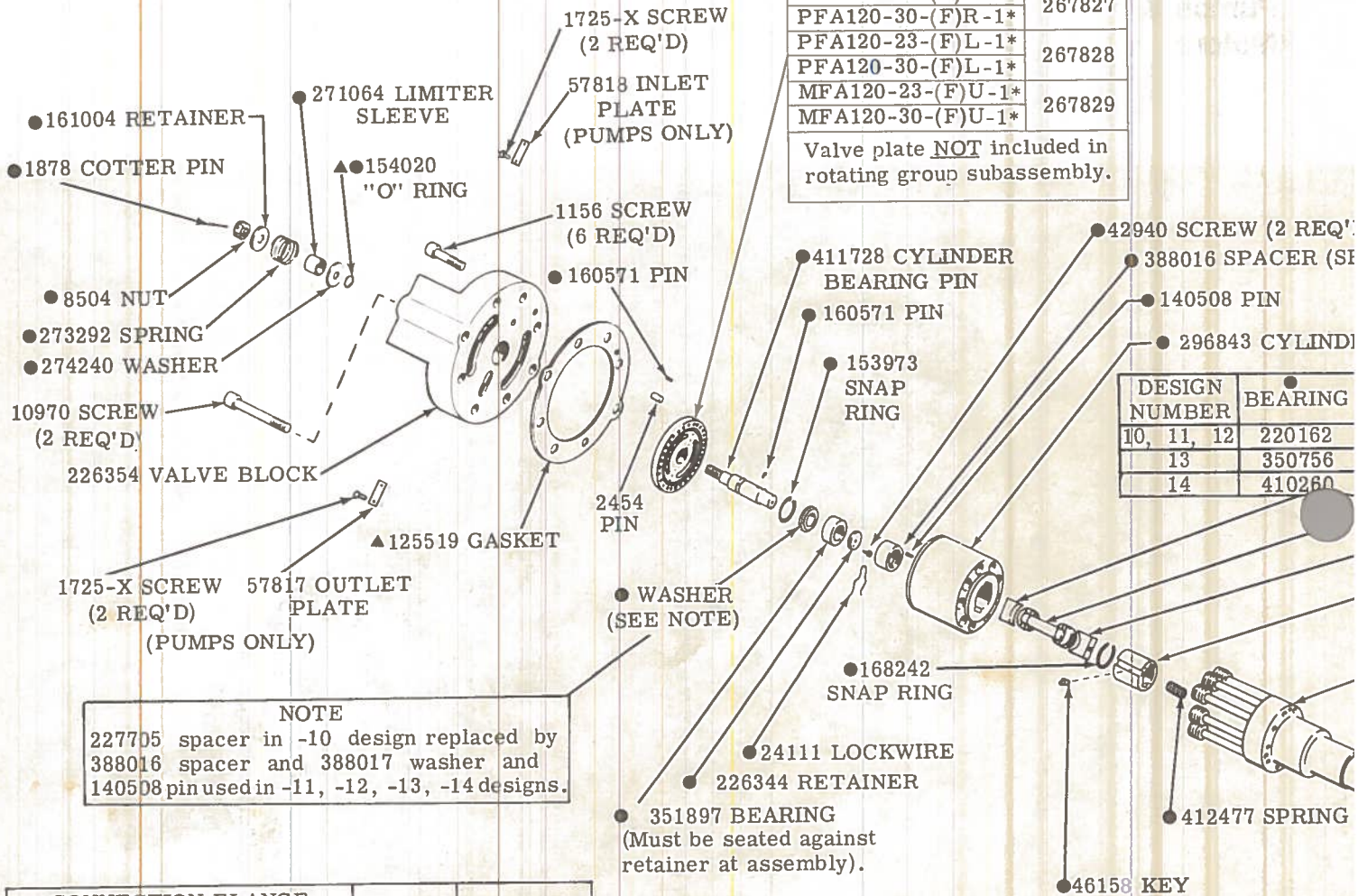
P.O. Box 302
Troy, Michigan 48007-0302

Revised 10-1-85

I-3221-S

⊖ OMIT THESE FACE TYPE SHAFT SEAL PARTS WHEN A ONE PIECE SHAFT SEAL IS USED (PVA120-10/11/12/13). FACE TYPE SHAFT SEALS ARE STANDARD ON THE -14 DESIGN ONLY.

⊖ -14 DESIGN FACE TYPE SHAFT SEAL S/A PARTS INCLUDED IN 942319.



MODEL	VALVE PLATE
PFA120-23-(F)R -1*	267827
PFA120-30-(F)R -1*	
PFA120-23-(F)L -1*	267828
PFA120-30-(F)L -1*	
MFA120-23-(F)U -1*	267829
MFA120-30-(F)U -1*	
Valve plate <u>NOT</u> included in rotating group subassembly.	

DESIGN NUMBER	BEARING
10, 11, 12	220162
13	350756
14	410280

NOTE
227705 spacer in -10 design replaced by 388016 spacer and 388017 washer and 140508 pin used in -11, -12, -13, -14 designs.

CONNECTION FLANGE MODEL NUMBERS		PIPING SIZE	FLANGE DESIGN
WELDED	THREADED		
FL-20-WS-20	FL-20-RS-20	2-1/2"	STRAIGHT
FL-20-WL-20	FL-20-PL-20	2-1/2"	ELL
FL-24-WS-20	FL-24-PS-20	3"	STRAIGHT
FL-24-WL-30	FL-24-PL-20	3"	ELL

FLANGE ASSEMBLY INCLUDES: FLANGE (1), "O" RING (1), SCREWS (4) AND WASHERS (4)

Flanges tabulated above are rated for 3000 PSI. Straight flanges with SAE Grade 8 screws for use to 5000 PSI can be supplied. Specify by adding "HP" to model number. Example: FL-20-WS-HP-20. Torque "HP" flange screws to 175 -200 lb. ft.

MODEL	ANGLE HOUSING
PFA120-23-(F)R -1*	249839
PFA120-23-(F)L -1*	
MFA120-23-(F)U -1*	
PFA120-30-(F)R -1*	237237
PFA120-30-(F)L -1*	
MFA120-30-(F)U -1*	

● INCLUDED IN ROTATING GROUP SUBASSEMBLY

▲ INCLUDED IN 919189 SEAL KIT

F3 EQUIVALENT SEAL KIT 920144

8504 NUT

297474 NUT

1076 SCREW

VERY IMPORTANT

To provide proper running clearance of cylinder block, tighten 8504 nut so valve block, valve plate and cylinder block are clamped snugly together. Then back the nut off from 1/6 to 1/4 turn to align the slot with the key hole in the pin.

VERY IMPORTANT

To insure proper running clearance of front and rear bearings, tighten nut 297474 so drive shaft sub-assembly and front bearing are clamped snugly together. Then back off nut until there is .003 to .005 clearance between nut and bearing. Insert screw 1076 in nut and tighten. Recheck clearance. Tap end of shaft until nut is flush with front bearing.

(E)

OCK

VERSAL & PIN	BEARING	RETAINER	SHAFT SUB-ASSY	ROTATING GROUP
0161	220162	220163	226033	938070
9456	341841	341842	344755	
9456	341841	388015	344755	

DRAIN CONNECTION INSTRUCTIONS

Any one of three drain connections may be used. A full size unrestricted case drain line must be connected from the drain port directly to reservoir in such a manner that the housing remains filled with fluid. Drain line loop must extend above top of case and terminate below fluid level in reservoir, to prevent syphoning action.

181822 PLUG (2 REQ'D)

▲154133 SEAL (2 REQ'D) For unused drain ports.

237238 HOUSING

●212887 BEARING

▲237712 GASKET

●235676 KEY

1155 SCREW
(8 REQ'D)

7075 PLUG

3X-36212 SCREW (2 REQ'D)

23746 ROTATION PLATE
(PUMPS ONLY)

PIN
BOLT

●231069 PIN
(4 REQ'D)

●220602 BEARING

●1076 SCREW

●297474 BEARING RETAINER NUT

○297634 SPRING (4 REQ'D)

○297472 SEAL (ROTOR)

○297473 SEAL (STATOR)

○▲262419 "O" RING

▲226035 GASKET

296845 SHAFT SEAL
(OMIT ON -14 DESIGN)

○297475 SEAL
RETAINER (-14)
226043 SEAL
RETAINER (-10
thru -13)

1050 SCREW
(8 REQ'D)

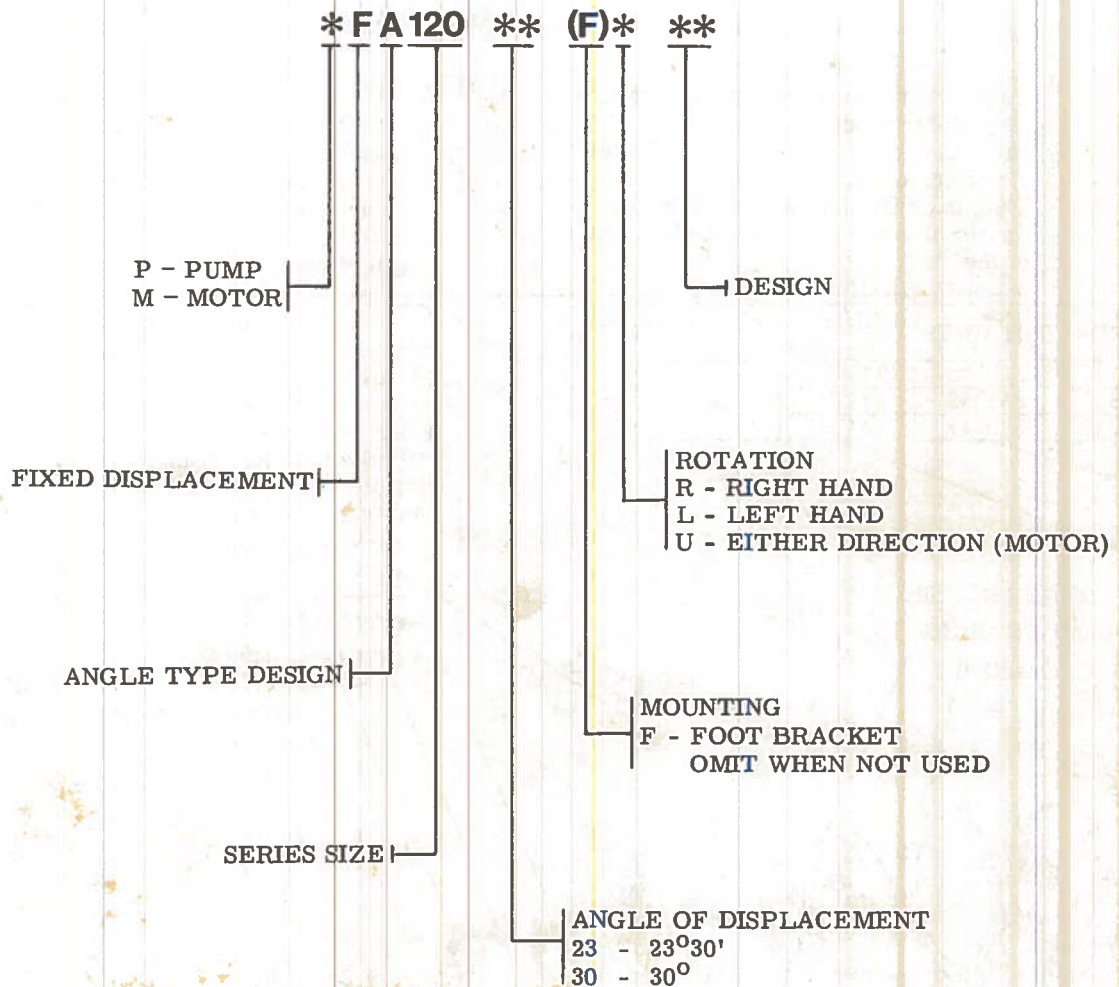
○▲262411
"O" RING

1173 SCREW
(8 REQ'D)

226078 MOUNTING

USE ON BRACKET MOUNTED
*FA-***-F*-1*

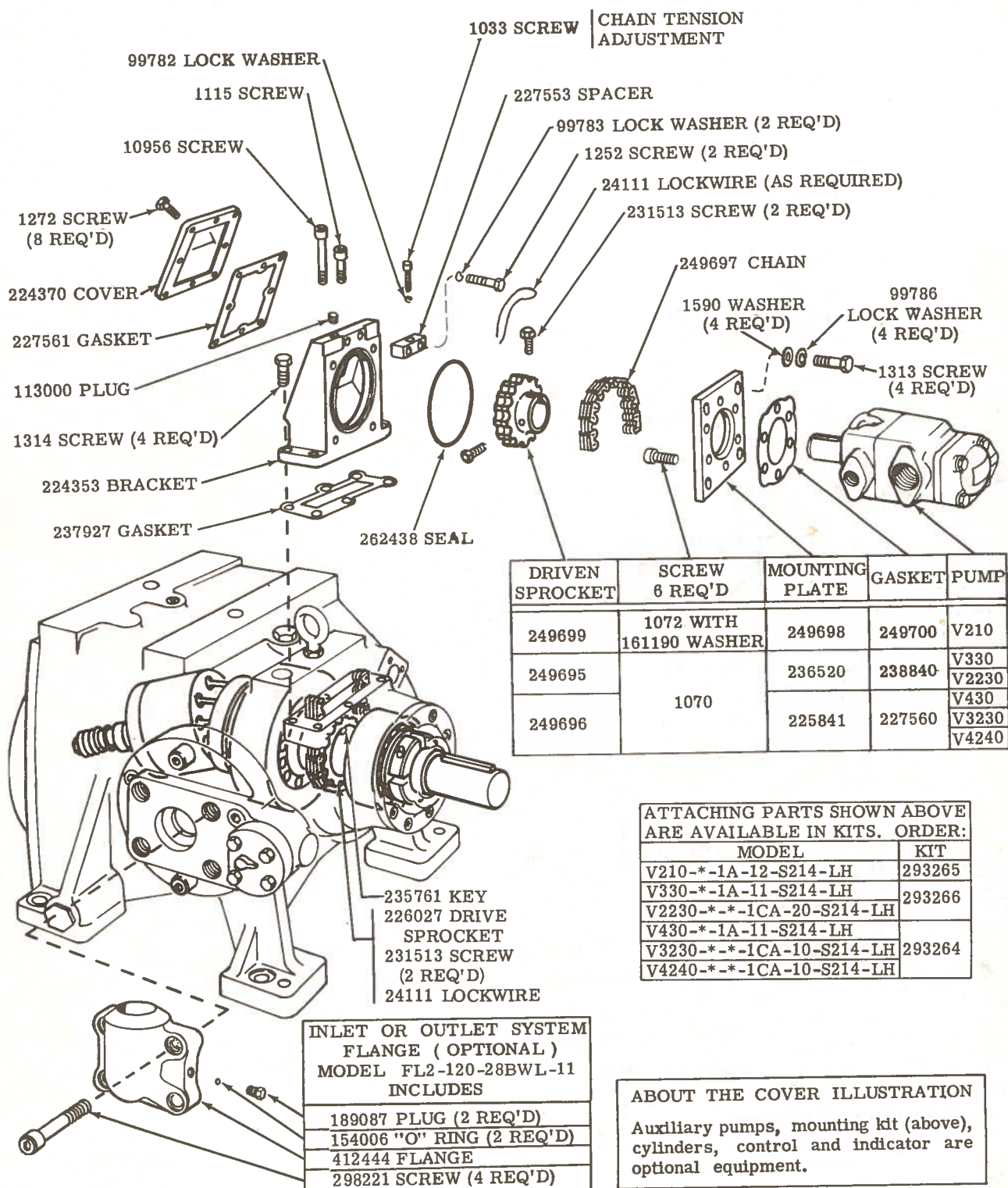
MODEL CODE BREAKDOWN



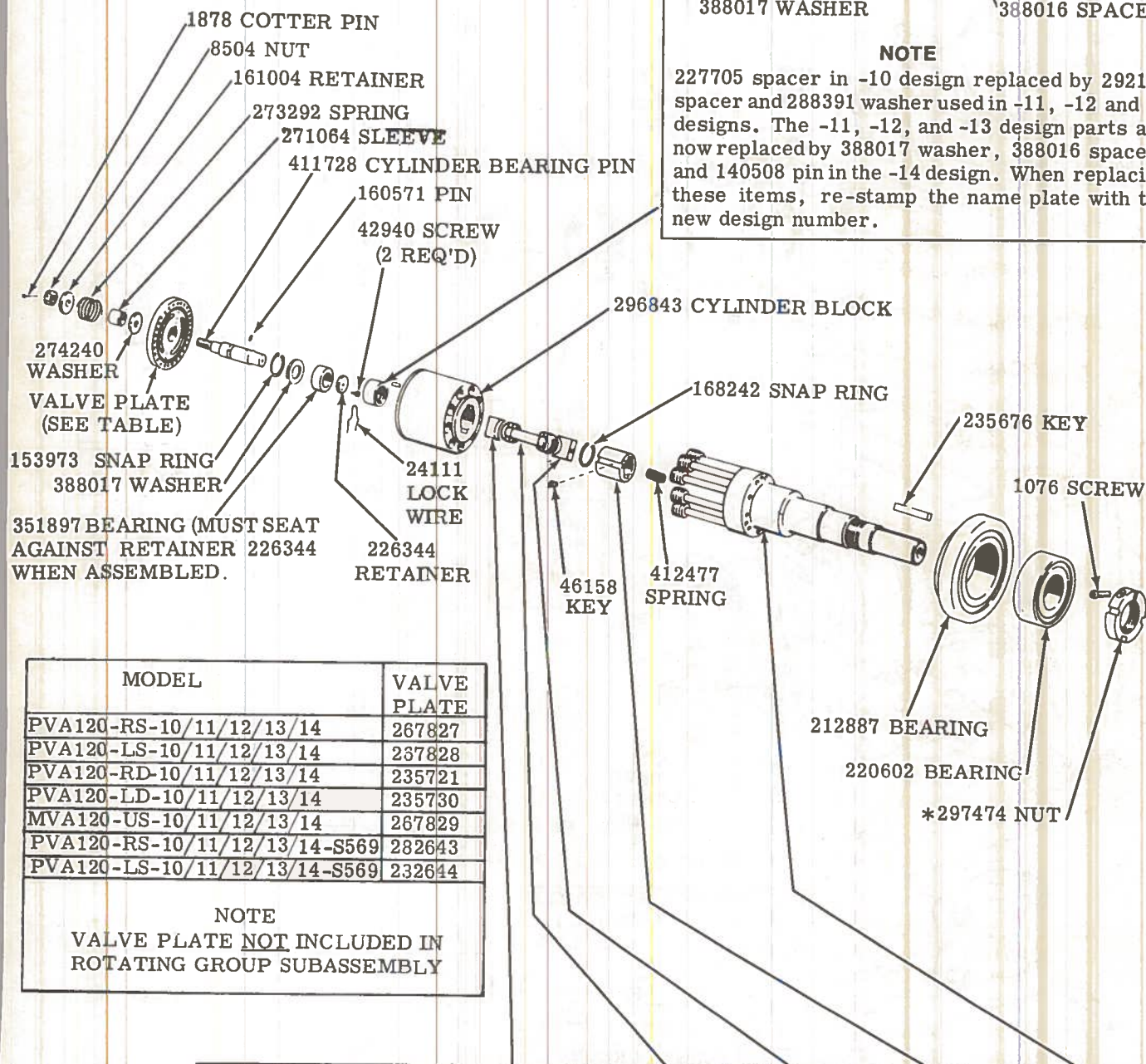
To insure sustained efficiency and maximum trouble-free life of this precision equipment, initial and continuous filtration of the fluid medium to 35 microns absolute or less is essential. (For information pertaining to Vickers economical filters, see bulletin 81-216.)

Litho in U.S.A.

AUXILIARY PUMPS: ATTACHING PARTS & SYSTEM FLANGES



ROTATING GROUP SUBASSEMBLY EXPLODED VIEW



MODEL	VALVE PLATE
PVA120-RS-10/11/12/13/14	267827
PVA120-LS-10/11/12/13/14	237828
PVA120-RD-10/11/12/13/14	235721
PVA120-LD-10/11/12/13/14	235730
MVA120-US-10/11/12/13/14	267829
PVA120-RS-10/11/12/13/14-S569	282643
PVA120-LS-10/11/12/13/14-S569	232644

NOTE
VALVE PLATE NOT INCLUDED IN ROTATING GROUP SUBASSEMBLY

DESIGN NUMBER	ROTATING GROUP	BEARING	UNIV. LINK & PIN	BEARING	RETAINER	SHAFT S/A
10, 11, 12	*	220162	220161	220162	220163	226033
13/14	938070	410260	349456	341841	388015	344755

*USE ROTATING GROUP 938070 TO SERVICE -10, -11, -12, -13, & -14 DESIGN UNITS.

F3 EQUIVALENT SEAL KIT 919619
(CONTAINS F3 "O" RINGS & GAS-
KETS FOR DESIGNS -10 THRU -14.
DOES NOT CONTAIN F3 ROTOR &
STATOR SEALS.)

ED WITH
ARY
OPTION

W (6 REQ'D)

38 COVER

YE BOLT

Q'D)

)

23746 ROTATION PLATE
3X-36212 SCREW (2 REQ'D)
45682 INSTRUCTION PLATE
1725-X SCREW (2 REQ'D)

NAMEPLATE
152416 SCREW (4 REQ'D)

3935 PLATE (2 REQ'D)
725-X SCREW (4 REQ'D)

55 "O" RING

BEARING

CER

OR THESE PARTS MAY BE ON OPPOSITE PINTLE
DEPENDING ON CONTROL ASSEMBLY. LO-
CATION FOR R. H. ROTATION SHOWN.

▲154086 "O" RING

▲197649 BACK-UP RING

269941 SHIM
(AS REQ'D)

224168 WAVE
WASHER

1175 SCREW (6 REQ'D)
TORQUE TO 185 ± 5 lb. in.

THIS FLANGE PART
OF CONTROL ASS'Y.

230185 SLEEVE

▲154086 "O" RING

▲230186 RING

▲154086 "O" RING

▲197649 BACK-UP RING

▲227625 GASKET

▲INCLUDED IN
919188 SEAL KIT

*942319 FACE TYPE SHAFT SEAL
CONVERSION KIT. (INCLUDES ALL
PARTS NECESSARY FOR INSTAL-
LATION INTO A 10, 11, 12, OR 13
DESIGN UNIT. -14 DESIGNS USE THE
FACE TYPE SEAL AS STANDARD.

230014 RING

230015 RING

1118-B SCREW (12 REQ'D)
TORQUE TO 70-80 lb. ft.

224935 PINTLE

□227558 SPACER

■266397 BEARING

▲237927 GASKET

▲200155 "O" RING

*297634 SPRING (4 REQ'D)

*231069 PIN (4 REQ'D)

*297472 SEAL (ROTOR)

*262411 "O" RING

*297473 SEAL (STATOR)

*262419 "O" RING

*226035 GASKET

*297475 SEAL RETAINER

*1050 SCREW (8 REQ'D)

⊕ USED ON STD -10/-11/-12/-13 DESIGNS.
FOR F3 FLUID APPLICATIONS, CON-
VERT TO SEAL ARRANGEMENT SHOWN
ABOVE. (KIT 942319)

⊕ 1050 SCREW (8 REQ'D)

⊕ 226043 RETAINER (STD. SEAL)

⊕ ▲265682 SHAFT SEAL

⊕ ▲226035 GASKET

● NOTE

ASSEMBLE 274978 SCREWS INTO HOUSING WITHOUT
SHIM 227554. ADJUST SCREWS TO LIMIT YOKE TRAVEL
AT $30^{\circ}(+1/2^{\circ}-0^{\circ})$. MEASURE GAP BETWEEN SCREW
AND HOUSING. GRIND THE SHIMS TO THIS DIMENSION
 $\pm .005$. APPLY VICKERS SEALANT 367410 TO SCREW
THREADS AND INSTALL THE SCREWS THROUGH THE
SHIMS INTO THE HOUSING.

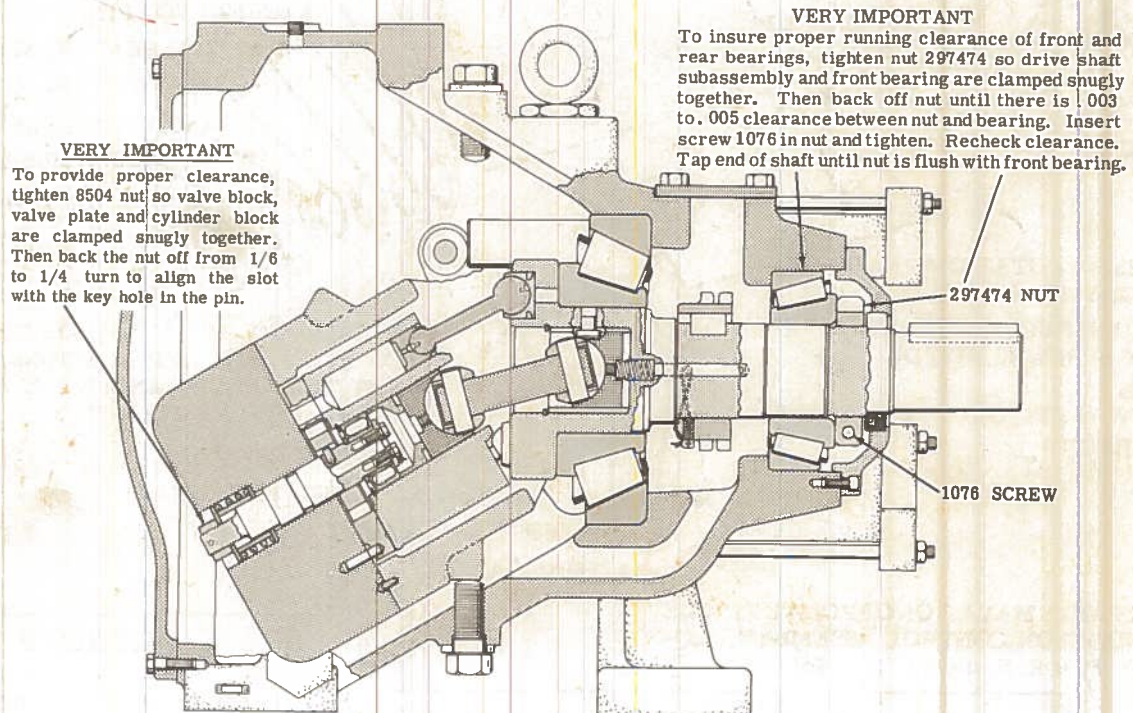
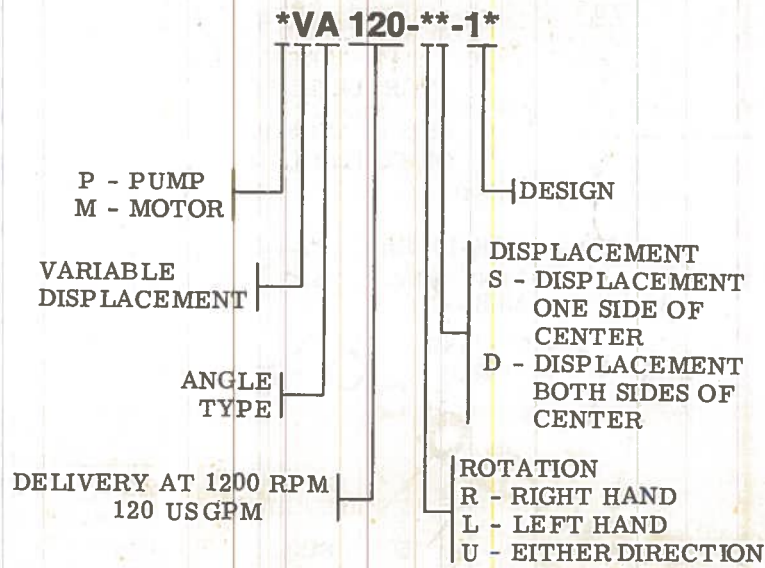
CONTROLS

COMPENSATOR CONTROL PARTS
SHOWN ON I-3210-S AND I-3211-S.

HYDRO-MECHANICAL CONTROL
PARTS SHOWN ON I-3214-S.

ELECTRO HYDRAULIC SERVO
CONTROL PARTS SHOWN ON
I-3206-S.

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

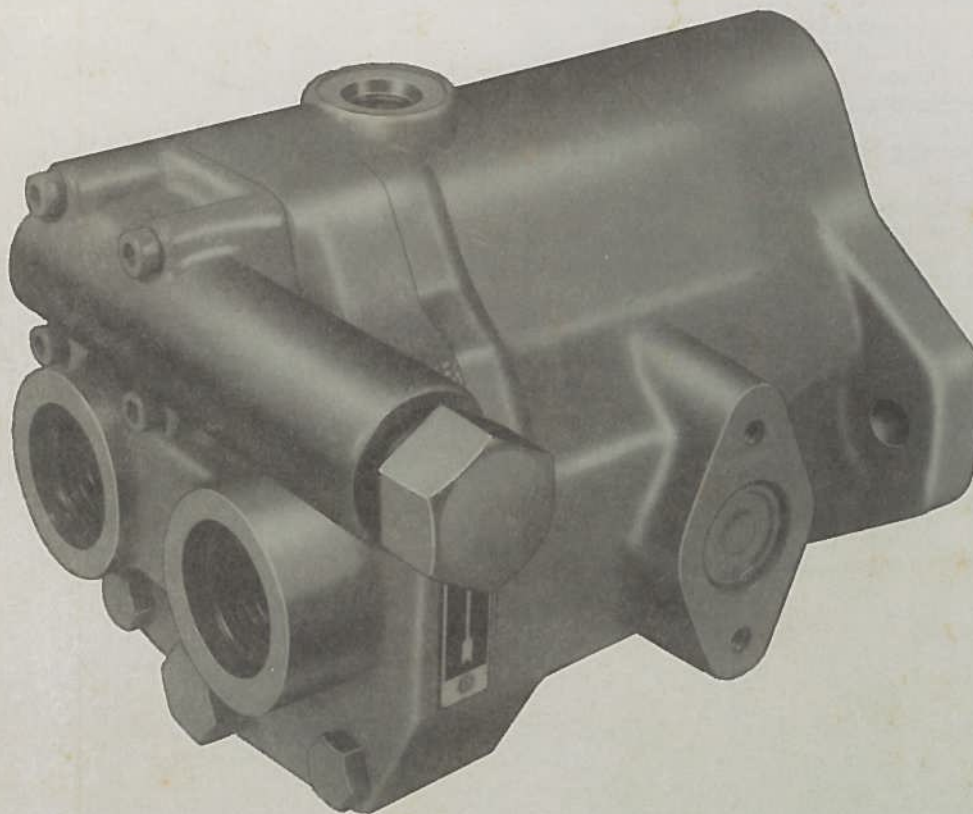
VICKERS®

A TRINITY COMPANY

Overhaul Manual

**Fixed & Variable
Displacement
Inline Piston
Pumps & Motors**

MFB Series
MVB Series
P(M)FB Series
P(M)VB Series



Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 7-1-86

I-3230-S

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Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual describes operational characteristics and overhaul information for the fixed and variable delivery inline piston type pumps and motors. The information contained herein pertains to the latest design series.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 1 are available

any Vickers sales representative or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

2. Model Codes - Variations within each basic model series are covered in the model code. Table 2 is a complete breakdown of the codes covering these units. Service inquiries should always include the complete unit model code number as stamped on nameplate located on housing.

MODEL	INSTALLATION DRAWING	PARTS DRAWING
M-MFB5	289420	I-3238-S
MFB5	520300	I-3238-S
MFB10	000324	I-3244-S
M-MFB15	000324	M-2765-S
M-MFB20	289420	M-2763-S
MFB20	000324	I-3247-S
M-MFB29	000324	M-2763-S
MFB29	520310	I-3741-S
MVB5	273831	I-3280-S
MVB10	273838	I-3268-S
M-MVB29	000324	M-2773-S
M-PFB5	289424	I-3238-S
PFB5	507725	I-3238-S
M-PFB10	289419	M-2202-S
PFB10	507727	I-3244-S
M-PFB15	289419	M-2202-S
M-PFB20	289426	M-2203-S
PFB20	507729	I-3247-S
M-PFB29	289426	M-2203-S
PVB5	508300	I-3280-S
PVB6	508300	I-3280-S
PVB6A	508275	I-3281-S
M-PVB10	289419	M-2212-S
PVB10	508400	I-3268-S
M-PVB15	000324	M-2212-S
PVB15	508400	I-3268-S
M-PVB20	000324	M-2213-S
PVB20	508500	I-3267-S
M-PVB29	000324	M-2213-S
PVB29	508500	I-3267-S
PVB45A	508890	I-3294-S

Table 1. Reference Material

MODEL CODE BREAKDOWN

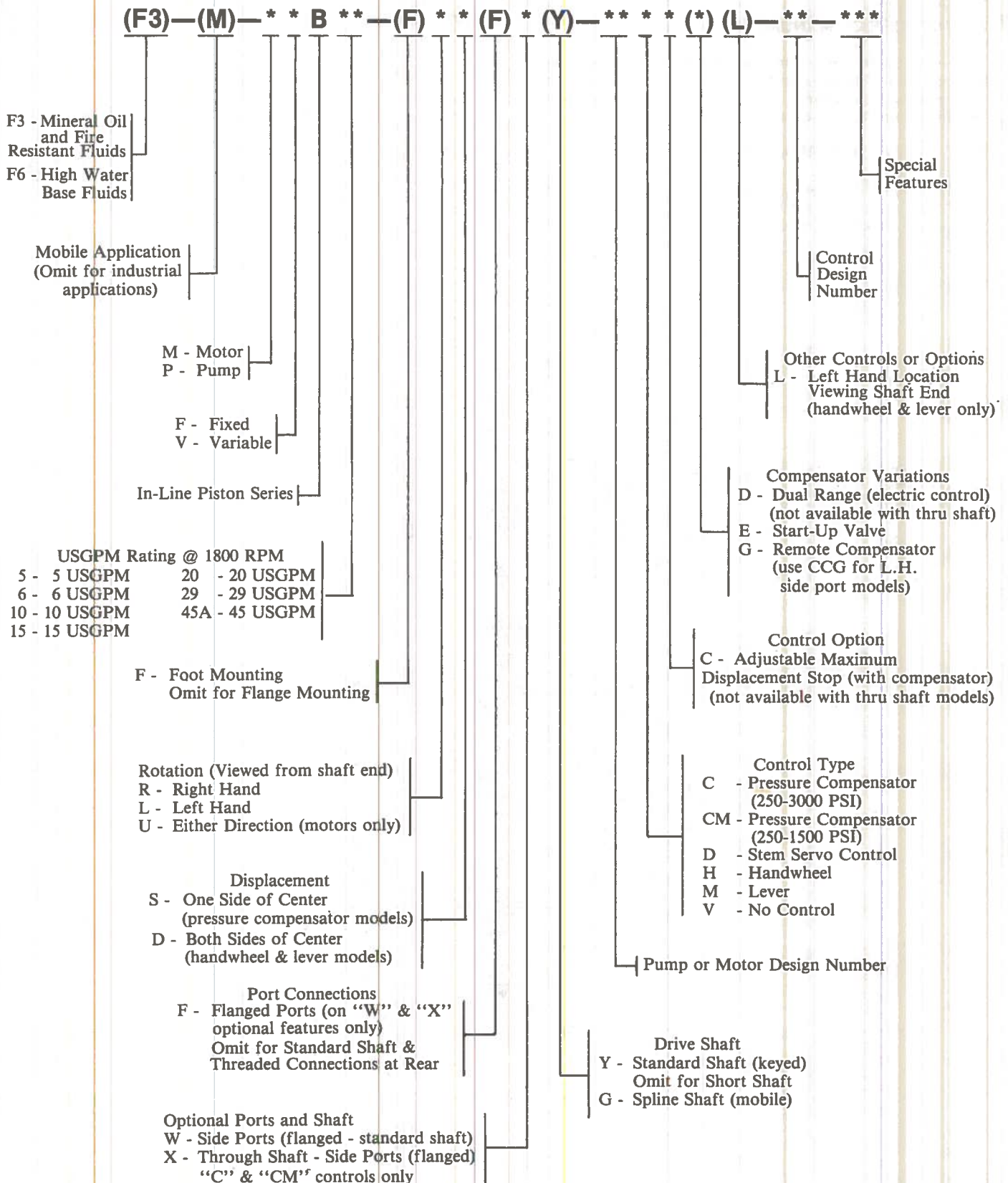


Table 2. Model Code Breakdown

Section II - DESCRIPTION

A. GENERAL

Vickers inline pumps and motors are of the axial piston, positive displacement type and include both fixed and adjustable (variable) displacement pumps and motors capable of high pressure operation. Drive speeds vary with the model, type of fluid used, and circuit application.

B. ASSEMBLY AND CONSTRUCTION

The assembly of typical fixed and variable displacement units

together with their A.N.S.I. symbols are shown in Figure 1. As illustrated, the major components of the inline unit are the housing, bearing-supported drive shaft, rotating group, swash plate and valve plate. The pressure compensated variable displacement units incorporate a pressure sensitive control piston, which governs the angle of the yoke and swash plate and consequently controls the stroke length of each piston as it rotates with the cylinder block and drive shaft. The valve plate subassembly also serves as the back cover of the entire unit and includes the inlet and outlet ports. A bearing in this cover and one in the housing support the drive shaft.

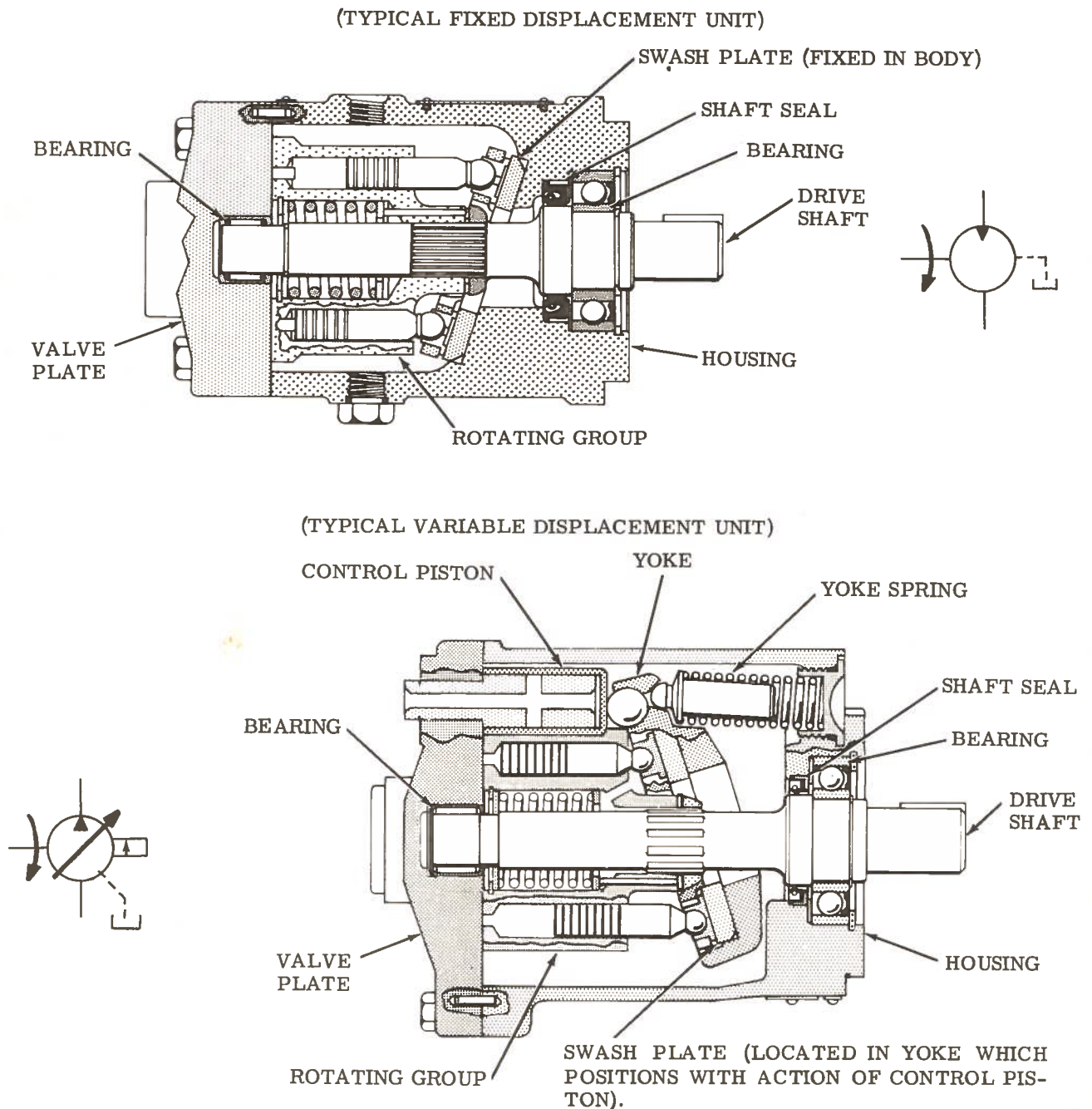


Figure 1. Typical Unit Assembly.

Section III - PRINCIPLES OF OPERATION

A. GENERAL

Although nearly identical in design, pumps and motors operate essentially in reverse of each other—the pump forcing fluid through the system as it rotates, the motor being rotated by the fluid. Variable displacement units are constructed so that the angle of displacement (angle of the swash plate to the drive shaft axis) can be varied by changing the yoke position.

B. MOTORS

Motors are positive displacement units which are capable of producing a variable torque and speed. Motor speed is a function of the input fluid volume and torque is a function of the input pressure. On a variable displacement motor, the angle of displacement (swash plate angle) also affects the speed and torque.

In operation, pressurized fluid is forced into the cylinder block bores which are open to the inlet port. Inlet pressure causes the pistons to exert a force against the swash plate. At the control point of the piston shoe and swash plate, a component of the angular counter-force causes the cylinder block to move in a rotary direction. The remaining cylinder block bores are either open to the outlet or blocked by the valve plate. When the pistons move across the outlet port, fluid discharges and returns to the reservoir or system.

Rotation is reversed by reversing the fluid supply to the motor or if the motor is a variable displacement type, it can be stroked across-center for reversal. If a variable unit is stroked across center, adequate precautions must be taken to prevent overspeed, overpressure and/or cavitation. "Stroking across center" means moving the swash plate from an angle on one side of center, to zero (center) angle of the yoke, and then to the opposite side of center.

Motors are used for continuous, intermittent, or continuously reversing service. They can be stalled indefinitely under load without damage when protected by a relief valve.

C. PUMPS

The operation of the pump is essentially in reverse of motor operation. During the time that a piston is moving out of the cylinder block bore, a pressure differential develops which forces fluid into the open cylinder block bores through the inlet port. As the cylinder block rotates past the outlet port, the pistons force fluid out into the system.

On variable displacement pumps, outlet volume is varied by changing the swash plate angle between the swash plate and the drive shaft axis. Since the swash plate angle is not variable on fixed displacement pumps, the flow is determined by pump size and speed driven (RPM).

Section IV - INSTALLATION

A. GENERAL

Installation drawings shown in Table 1 should be consulted for correct installation information.

B. MOUNTING AND DRIVE CONNECTIONS

CAUTION

Pump/motor shafts are designed to be installed in couplings with a slip fit. Pounding can injure the bearings. Shaft tolerances are shown on the installation drawings. (See Table 1.)

A pilot on the pump/motor mounting flange assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening the mounting screws to prevent misalignment.

Mount the unit with the drain line connection at the top. This will allow easy filling of the housing before start-up and also prevent draining of the housing in periods of idleness. There should be no restriction between the drain port and the reservoir. The drain line must terminate below reservoir fluid level.

C. INLET LINE

Inlet lines must have sufficient capacity to allow full flow requirements at the pump or motor inlet for all conditions of operation. The use of restrictive inlet tubing, undersize filter or an improper grade of fluid may result in inlet vacuum conditions exceeding the recommended five inches of mercury and cause cavitation in pumps. Cavitation is the rapid formation

and collapse of vapor pockets within the fluid and can cause excessive damage to the unit. Motor inlet lines must be of the high pressure type to withstand the output pressure of the associated pump. Check the appropriate installation drawing for maximum motor/pump speed. (See Table 1.)

D. FILTRATION

Vickers recommends the use of inlet, pressure and/or return line filtration. Inlet filters can be supplied with magnets and a contamination indicator or an electrical switch. The electrical switch feature can be used to actuate an alarm when the filter element is plugged. Vickers field engineering personnel should be consulted when unusual fluids or viscosity conditions are encountered.

E. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling.

NOTE

For instructions on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

F. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps and motors. Any oil selected for use with pumps is acceptable for use with valves or motors.

Data sheet I-286-S for oil selection is available from Vickers Technical Publications, Troy, Michigan 48084.

Oil recommendations noted in the data sheet is based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales engineer.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean.

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of oil to prevent introduction of contaminants into the system.
3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.
5. During usage, proper oil filling and servicing of oil filters, breathers, reservoirs, etc., cannot be over emphasized.
6. Thorough precautions should be taken by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in hydraulic systems are:

1. Very high viscosities at start-up temperatures can cause noises due to cavitation.
2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.
3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity in discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

G. OVERLOAD PROTECTION

Both fixed and compensated pumps require an external relief valve to provide maximum protection of circuit components. An external relief valve is also required in the inlet line of a hydraulic motor to limit the pressure and torque.

H. STARTING AND PRIMING

Before initial starting, fill the housing with clean fluid. Normal "leakage" past the pistons or between the cylinder block and valve plate provides internal lubrication of working parts. To assure initial priming of variable displacement units, adjust the controls to provide at least 40% of maximum displacement at start-up. The control may be reset to a lower displacement after priming is accomplished.

It may be necessary to bleed air from the pump outlet line to permit priming and reduce noise. Bleeding may be accomplished by loosening an outlet connection until a solid stream of fluid appears. An automatic air bleed valve (ABT-02-10) can be permanently installed and will eliminate the necessity to loosen a connection.

Section V - SERVICE AND MAINTENANCE

A. SERVICE TOOLS

The following standard tools are required for overhaul of a piston type pump or motor:

1. Torque wrench with socket adapters
2. Set of U.S. hex key wrenches
3. Set of small pin punches
4. 3/8 inch socket set with ratchet
5. Small ball peen hammer
6. Steel scale
7. Micrometer (0-1 inch)
8. Dial indicator

An arbor press is also required for assembly of shaft and pintle bearings.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be cleaned regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher than normal pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the bypass to open, resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin the pump and other components. If bubbles are seen, locate the source of the air and seal the leak.

5. A pump or motor which is running excessively hot or noisy is a potential failure. Should a unit become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance

which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation through the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacture of our parts. Substitutions may result in early failure. Part numbers are shown in the parts drawings listed in Table 1.

G. TROUBLESHOOTING

Table 3 lists the common difficulties experienced with piston pumps and motors. It also indicates probable causes and remedies for each of the troubles listed.

Section VI - OVERHAUL

A. GENERAL

CAUTION

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

After removing pump or motor from system and before disassembly, cap or plug all ports and disconnected lines. Clean the outside of the unit thoroughly to prevent entry of dirt into the system.

CAUTION

Absolute cleanliness is essential when working on a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Discard and replace all "O" rings, gaskets and shaft seals removed during disassembly.

B. DISASSEMBLY

All models are disassembled in the same general sequence as shown in the exploded view, Figure 2.

NOTE

This procedure is written for a basic compensator model. If a control other than a compensator is used, refer to the appropriate service parts drawing for information on the control.

Parts should be placed on a clean piece of Kraft paper in the order of disassembly.

1. Remove four screws (1) from compensator body (2).
2. Remove compensator body (2) from valve plate subassembly (7).
3. Remove gasket (3), "O" ring (4) and retaining ring (5) from piston rod (9).
4. Remove six screws (6) from valve plate subassembly (7).
5. Remove valve plate subassembly (7) from housing (36). Place valve plate subassembly on a clean piece of Kraft paper with machined surface up. Remove piston rod (9), spacer (10) and piston (11) from valve plate (7). (Note: Spacer does not exist in all models.)
6. Remove gasket (8) and discard.

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	Reservoir fluid level low. Intake filter or pipe plugged. Air leak in intake line prevents priming. Coupling or shaft sheared or disengaged. Pump driven in wrong direction of shaft rotation.	Add fluid and check level on both sides of reservoir baffle to insure pump intake line is submerged. Clean filters of lint soon after new fluid is added. Pour fluid on intake joints while listening for change in sound of operation. Tighten as required. Disassemble pump and check shaft and rotating group for damage. Replace necessary parts. Check installation. Reverse the drive or convert pump as discussed in the overhaul section.
SYSTEM NOT DEVELOPING PRESSURE	Contamination in actuating control. Pump not delivering fluid for any of the above reasons. Relief valve setting not high enough. Relief valve sticking open. Leak in hydraulic control system (cylinders or valves). Free circulation of fluid to reservoir.	Clean control Check circulation by watching fluid in reservoir. Block machine travel. Test with pressure gauge. Remove contamination in relief valve. Test independently by progressively blocking off the circuit. Insure that directional valve is not in open center (neutral) position or that fluid is not discharging to tank through an open line or improperly adjusted valve.
PUMP MAKING NOISE	Partly clogged intake line, intake filter, or restricted intake pipe. Air leak at pump intake pipe joints. Air bubbles in fluid. Reservoir air vent plugged. Pump running too fast. Filter too small on intake. Coupling misalignment.	Pump must receive intake fluid freely or cavitation takes place. Tighten as required. Pour fluid on joints while listening for change in sound of operation. Check to be certain return lines are below fluid level and well separated from intake line. Must be open through breather opening or air filter. Conform with recommended maximum speeds on installation drawings. Refer to appropriate installation drawing for proper size filter. Check for damaged shaft bearing or other parts. If necessary, replace and realign the coupled shafts.
MOTOR SHAFT DOES NOT TURN. INSUFFICIENT SPEED OR POWER.	System overload relief valve set too low to permit necessary pressure. Valve plate and cylinder block surface scored by abrasive in hydraulic fluid.	Check pressure and increase relief valve setting, but not above recommended maximum. Check external leakage at drain port. Remove motor. Install new rotating group. Replace scored valveplate. Flush system with clean oil.
MOTOR TURNING IN WRONG DIRECTION	Pump or other components in system not functioning properly. Incorrect connection.	Check directional control and pump stroke position. Check circuit and connect correctly.
EXTERNAL LEAKAGE FROM MOTOR	Worn seal or gaskets. Gaskets leaking due to improperly connected reservoir drain.	Install new seal and/or gaskets. Connect drain line directly to reservoir below the fluid level.
SPEED FLUCTUATIONS WITH CONSTANT INPUT FLOW	Irregular wear between valve plate and cylinder block.	Replace damaged parts.

Table 3. Troubleshooting Pumps/Motors

7. The rotating group consists of retaining ring (12), lift limiter (13), spring (14), thrust washer (15), cylinder block (16), pins (17), backup washer (18), spherical washer (19), shoe plate (20) and piston/shoe subassembly (21). Turn the rotating group slightly to free it from the swash plate (22). Tilt housing

(36) and remove the rotating group. During removal, use care to prevent separation of the rotating group. Disassemble the rotating group as follows: (Refer to Figures 2 and 3 during disassembly.)

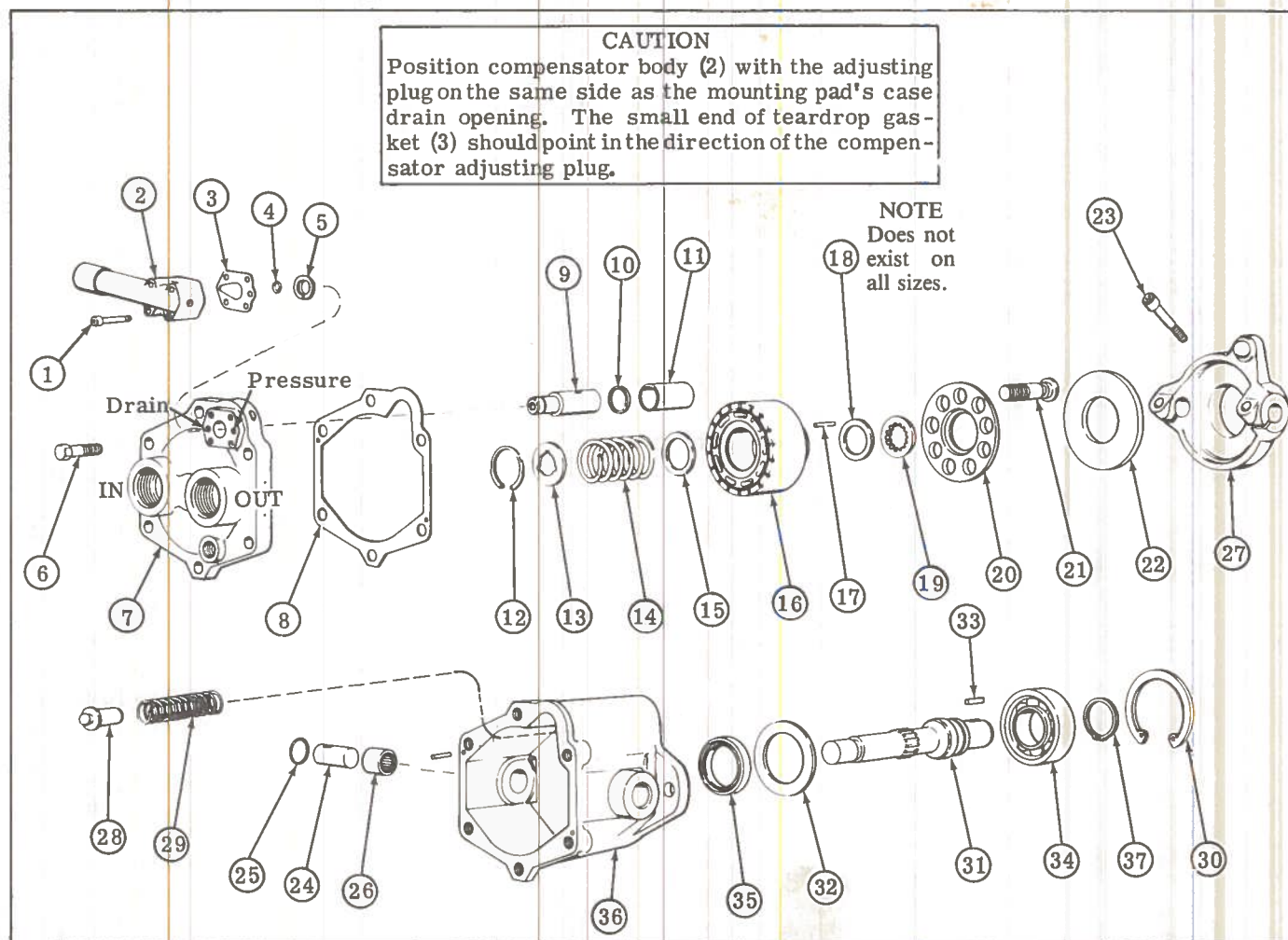


Figure 2. Exploded Parts Breakdown

ITEM	NOMENCLATURE	QTY.	ITEM	NOMENCLATURE	QTY.
1	Screw (Compensator)	4	19	Spherical Washer	1
2	Body (Compensator)	1	20	Shoe Plate	1
3	Gasket (Compensator)	1	21	Piston/Shoe Subassembly	9
4	'O' Ring (Compensator)	1	22	Swash Plate	1
5	Retaining Ring (Compensator)	1	23	Screw (Yoke)	2
6	Screw	6	24	Pintles	2
7	Valve Plate	1	25	'O' Ring (Pintle)	2
8	Gasket	1	26	Bearing (Pintle)	2
9	Piston Rod	1	27	Yoke Subassembly	1
10	Spacer	1	28	Seat	1
11	Piston	1	29	Spring	1
12	Retaining Ring	1	30	Retaining Ring	1
13	Lift Limiter Washer	1	31	Drive Shaft	1
14	Spring	1	32	Shaft Seal Retainer	1
15	Thrust Washer	1	33	Drive Shaft Key	1
16	Cylinder Block	1	34	Bearing (Drive Shaft)	1
17	Pin	3	35	Shaft Seal	1
18	Backup Washer	1	36	Housing	1
			37	Retaining Ring (Bearing)	1

Figure 2. Part Nomenclature

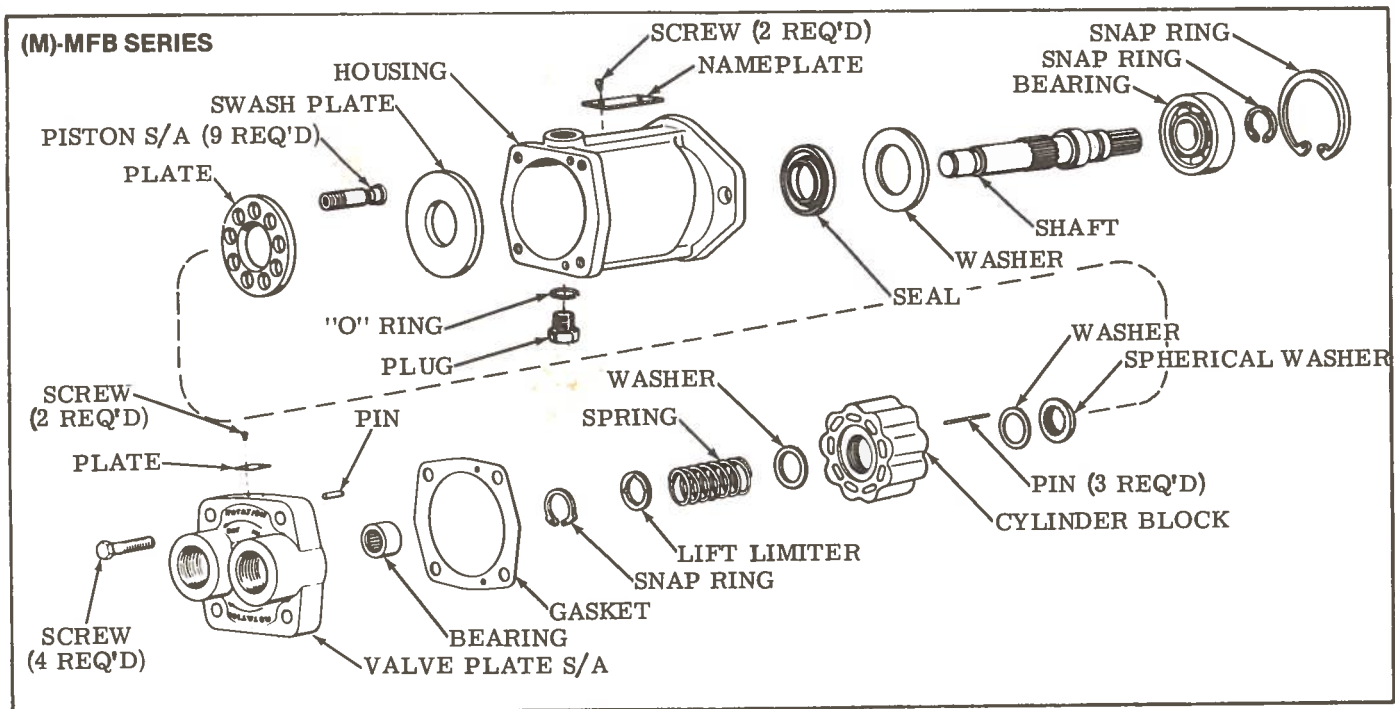


Figure 2a. Typical Fixed Displacement Motor

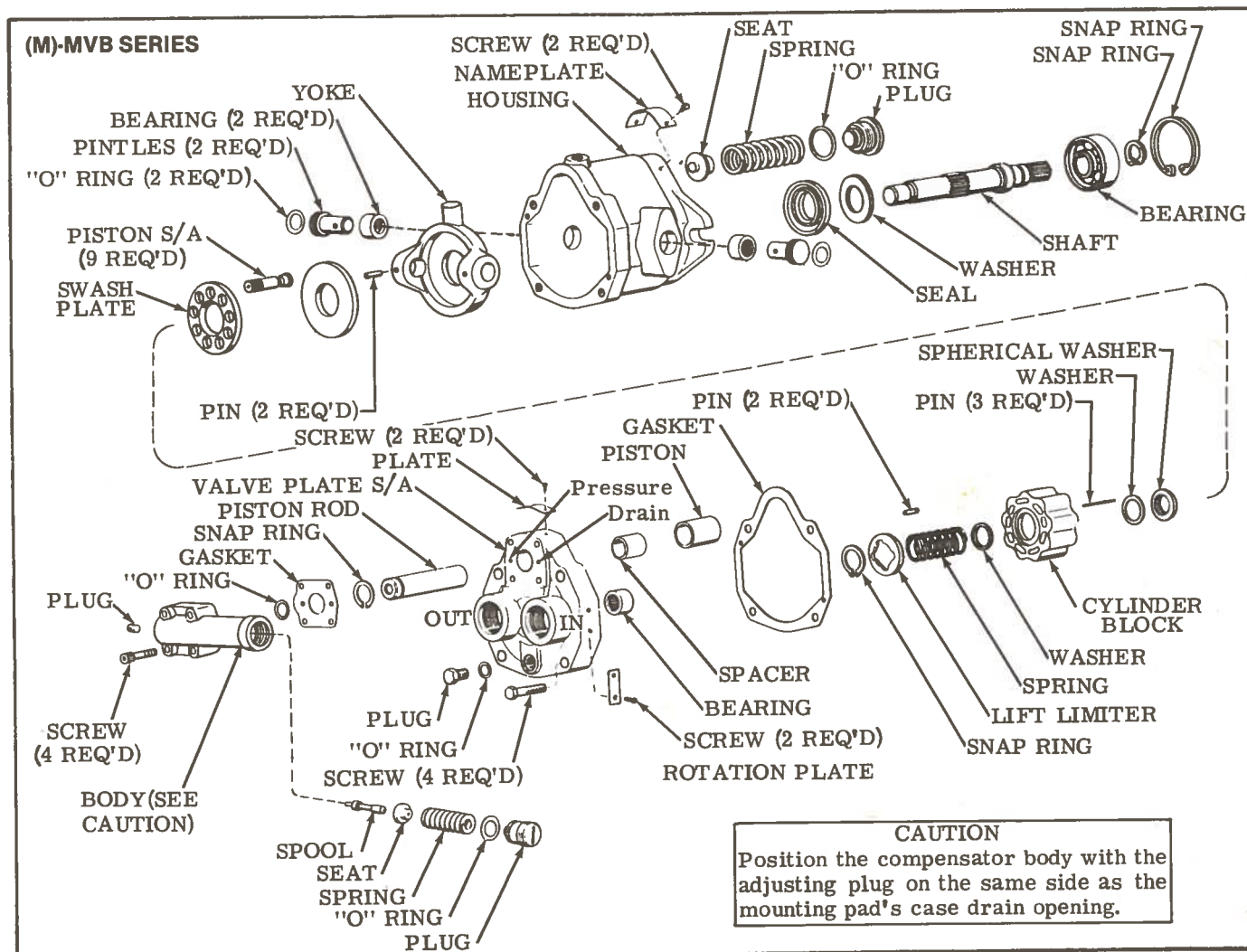


Figure 2b. Typical Variable Displacement Motor

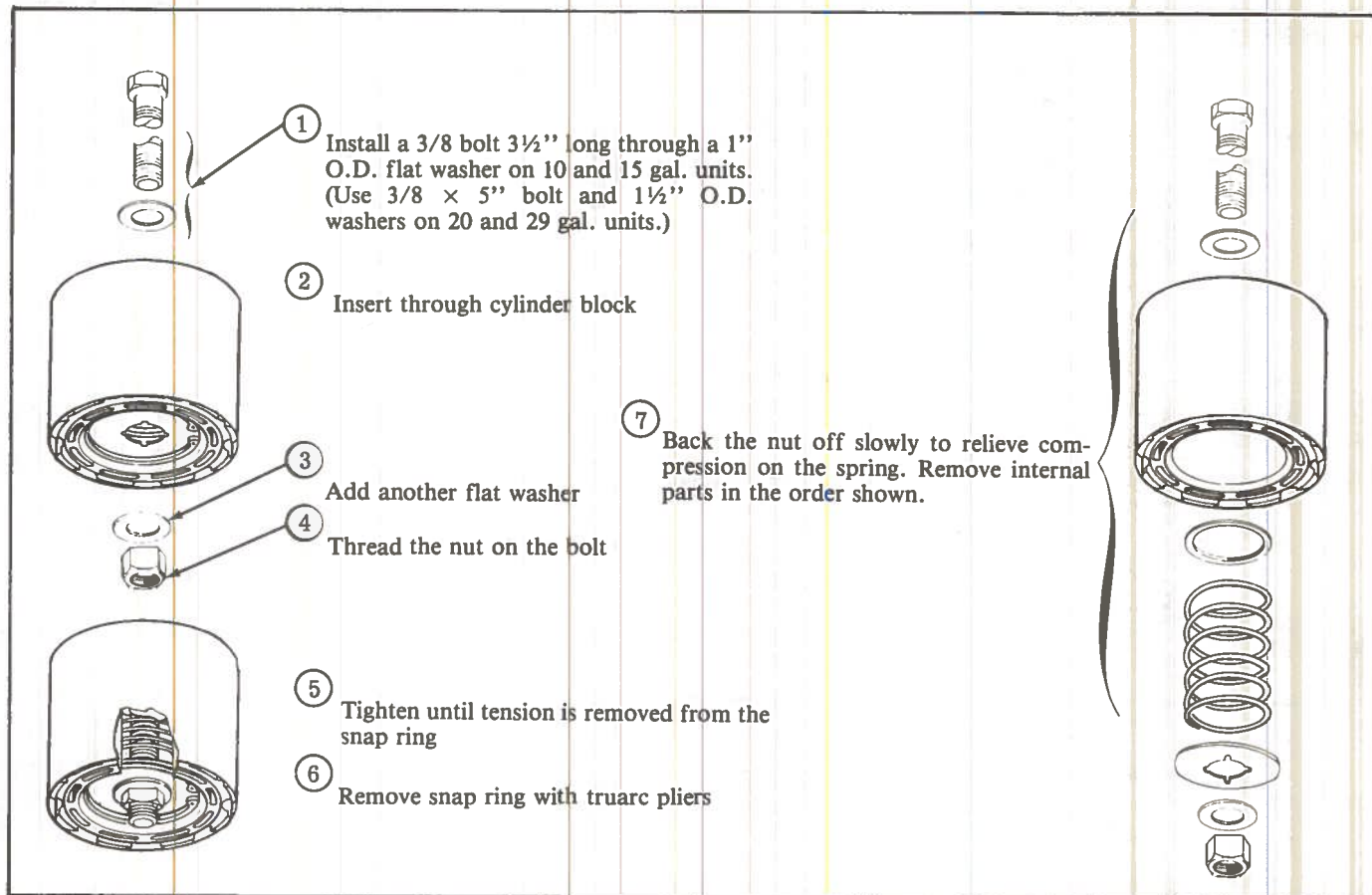


Figure 3. Cylinder Block Disassembly

a. Place the rotating group face down on a clean piece of Kraft paper.

b. Grasp shoe plate (20) and lift nine piston and shoe subassemblies (21) from cylinder block (16) with the shoe plate. Be careful not to strike the pistons together hard enough to create a burr or damage the pistons.

c. Remove spherical washer (19), backup washer (18) and pins (17). (Note: Some units do not use a backup washer.)

d. Observe caution during removal of spring (14) located within the cylinder block. The spring is under high compression and can cause bodily harm if retaining ring (12) is removed without adequate tooling. See Figure 3 for removal procedure.

8. Remove retaining ring (30) from housing (36) with truarc pliers.

9. Remove drive shaft (31), bearing (34), key (33), and retaining ring (37) from mounting flange of housing (36). Set aside for inspection.

10. Remove swash plate (22) from yoke subassembly (27). Rotate swash plate (22) and pull evenly from the yoke. Set aside for inspection.

11. Remove two screws (23) from yoke (27).

12. Remove pintles (24) with "O" rings (25) from yoke (27). Refer to Figures 4 and 5.

13. Remove yoke (27), refer to Figures 4 and 5, the yoke removal procedure for a variable displacement pump or motor.

14. Variable displacement units require removal of seat (28) and spring (29) from within housing (36).

15. Remove washer (32) and shaft seal (35) from the housing. Be careful during the removal of the shaft seal. DO NOT scratch the housing to seal mounting surface. Leakage can occur between the seal and housing if the aluminum housing is scratched.

C. INSPECTION, REPAIR AND REPLACEMENT

Prior to inspection, clean all parts thoroughly with a solvent that is compatible with system fluid. Replace all parts that do not meet the following specifications.

1. Valve Plate (7) - Lapping of the valve plate is not recommended. If wear or scoring is apparent, replace the valve plate. Check the shaft bearing located within the valve plate for roughness and pitting of the rollers. Replace if defective. Remove paint and/or burrs from outer edge of valve plate with an India stone.

2. Piston Rod (9), Spacer (10) and Piston (11) - Inspect compensator piston rod and piston for fit and/or wear. Spacer (10) is used on some models to limit maximum flow. Replace if defective.

3. Rotating Group Parts

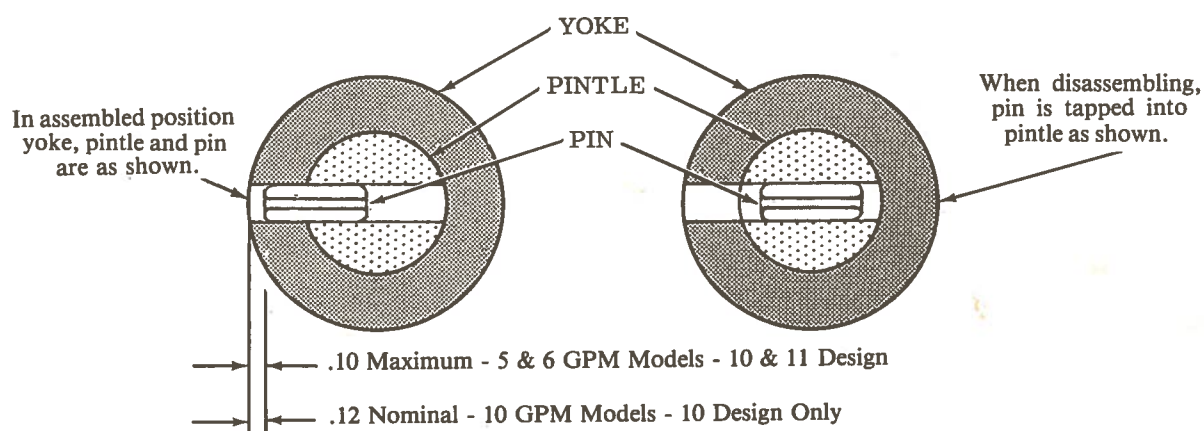
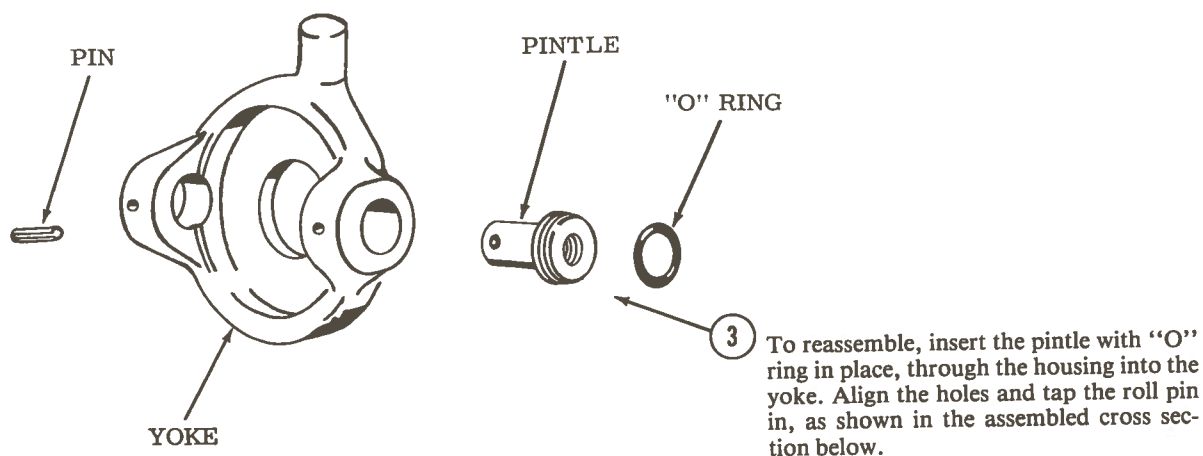
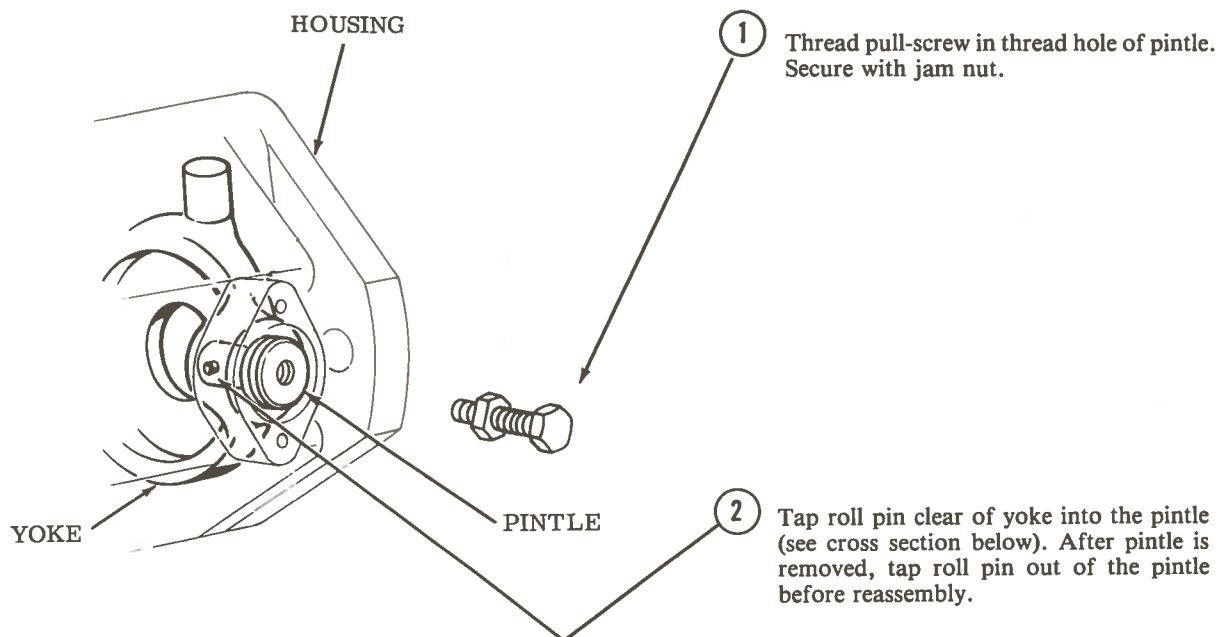
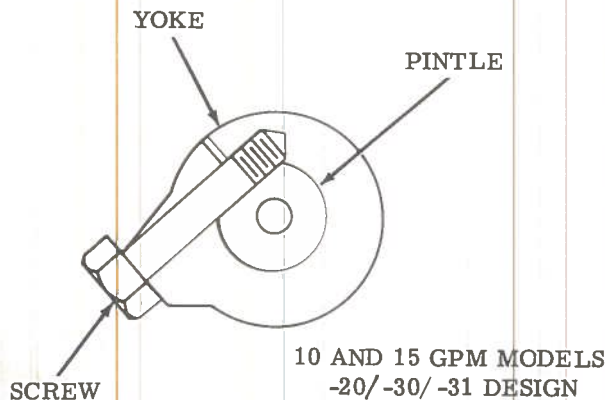
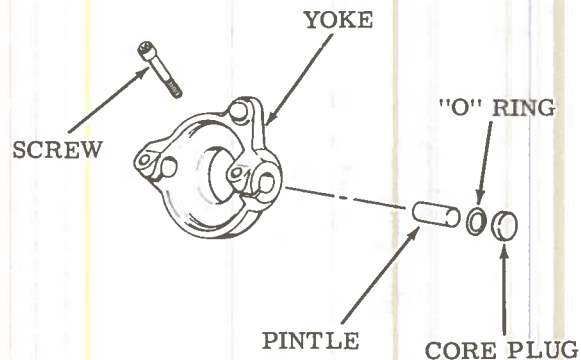


Figure 4. Removal of Pintle and Yoke, Smaller Models

The 10 and 15 GPM units of the -20/30/31 designs use a screw in lieu of the roll pin for securing pintles. The pintles are provided with a groove in place of the drilled hole to accept the screw (see cross section below).



- (1) Remove the core plug. Back-off lock screw at yoke until pindle groove clears for 20 and 29 GPM models. Lightly tap pindle toward inside of unit to remove. NOTE: Swash plate must be removed from yoke to remove these pintles.



- (2) To reassemble, insert the pindle through the housing into the yoke. Align the grooves and thread in lock screw.

20 AND 29 GPM MODELS

Figure 5. Removal of Pindle and Yoke, Larger Models

a . Inspect shoe plate (20) for wear or cracking in the area of spherical washer (19). If wear or cracks are found, replace the shoe plate and spherical washer at the same time.

b . Check spherical washer (19) for burrs and wear. Replace if defective.

c . Inspect pins (17) for equal length, wear and possible bending. Replace all pins simultaneously if one is defective.

d . Backup washer (18) does not exist in all models. Check for wear and replace if necessary.

e . Check each cylinder block (16) bore for excessive wear. Use the piston/shoe subassemblies (21) for this purpose. The piston should be a very close fit and slide easily in and out of the bore. No bind can be tolerated. If binding occurs, clean the cylinder block and piston, lubricate with clean hydraulic fluid and try again. Even minor contamination of the fluid can cause the piston to freeze up in the cylinder block bore.

f . Inspect each piston and shoe subassembly (21) for a maximum end play of 0.003 inch between the piston and shoe. The face thickness dimension, as shown in Figure 6, of each shoe must be within 0.001 inch of each other. A variation greater than 0.001 inch between all nine shoes indicates excessive wear. If one shoe needs replacement, replace all piston/shoe subassemblies. Replacement as a matter of procedure is recommended to obtain maximum overhaul life of the unit.

g . Inspect retaining ring (12), lift limiter washer (13), spring (14) and thrust washer (15) within cylinder block (16) for wear. Replace if necessary.

4. Inspect the face of swash plate (22) for wear, scratches and possible fracture. If the swash plate needs replacement, make sure the new swash plate rests flat against the face of yoke subassembly (27).

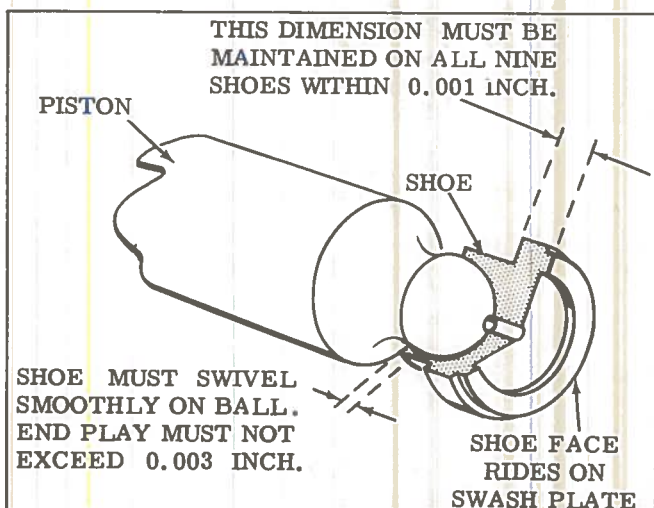


Figure 6. Piston and Shoe Assembly Tolerances

5. Inspect drive shaft (31) for wear, a chipped spline and burrs. Remove burrs with an India stone. Inspect the contact area of the shaft seal for wear and/or scoring. Replace the drive shaft if wear or scoring is greater than 0.005 T.I.R. (total indicator reading).

6. Inspect drive shaft bearing (34) for roughness in turning, pitting of the rollers and excessive end play. Replace if defective. If the bearing or shaft require replacement, removal of the bearing from the shaft is required. Use appropriate tooling to hold the inner race of the bearing and press the shaft from the bearing. Assemble new parts together in a similar manner, always applying force to the shaft and inner race of the bearing. DO NOT apply force to the outside bearing race. Install retaining ring (37).

7. Inspect yoke subassembly (27) face for wear, roughness or scoring. Check pintle bores of yoke for wear. Replace if defective.

8. Inspect pintles (24) and pintle bearings (26) for wear. Replace if defective. If a pintle bearing requires replacement, use a tool smaller than the housing bore and drive the pintle bearing into the housing and remove. Be careful not to score the housing bore during removal. Clean up the bore and lubricate both the bore and new pintle bearing with system fluid. Be very cautious during installation of new pintle bearings. If a bearing is misaligned with the bore at start of press, the bearing cage will warp and a bind will occur. Use an arbor press to install new pintle bearings. DO NOT press a bearing past the inside lip of the housing or interference with the yoke will result.

9. Inspect housing (36) mounting flange for nicks and burrs. Remove with an India stone. Remove paint and/or burrs from outer edge of housing.

D. ASSEMBLY

Assembly is performed in the reverse order of disassembly. Special procedures are noted in the following text.

A new seal kit should be obtained. Refer to the parts drawing for your model (see Table 1). Replace all seals, gaskets and "O" rings with new ones from the kit. A light film of clean hydraulic fluid will provide ease of assembly and initial lubrication of moving parts. Assemble as follows:

1. Install new shaft seal (35) into housing (36) with spring loaded member facing into the housing.

2. Install spring (29) over spring guide in housing. Insert seat (28) into spring.

3. Install yoke (27) in housing (36) as illustrated in Figures 4 and 5. Make sure seat (28) is in position and engages within the yoke.

4. Install pintles (24) and "O" rings (25) as illustrated in Figures 4 and 5. Install screws (23) and torque to recommended values. Refer to parts drawing for applicable unit found in Table 1.

5. Place shaft seal retainer (32) over shaft seal. Install drive shaft (31) and retaining ring (30) up against bearing into housing groove.

6. Lubricate and install swash plate (22) with chamfer side facing yoke (27). It is important that the swash plate be properly seated within the yoke and can be freely moved (rotated) with the fingers.

7. If the cylinder block was disassembled, refer to Figure 3 for assembly. Place the cylinder block face down on a clean piece of Kraft paper and insert three pins (17) into the cylinder block. Lubricate back-up washer (18) (not used on some models) and spherical washer (19), place them over pins (17). Lubricate the cylinder block bores and pistons with system fluid. Install the nine pistons (21) through shoe plate (20) and into the cylinder block bores. The pistons must move freely within the bores. The rotating group is now assembled and ready for installation into the pump or motor housing. Hold cylinder block (16) and shoe plate (20) together to keep pins (17) and washer(s) (18 & 19) intact, then install rotating group over the drive shaft. A slight rotation of the drive shaft during assembly will help align spherical washer (19) and cylinder block (16) splines with those of the shaft.

8. Lubricate the face of the valve plate. Make sure paint and burrs have been removed from the outer edge of housing (36) and valve plate (7). Install gasket (8) on housing (36).

9. Install piston rod (9) into valve plate. Slide retaining ring (5) over piston rod (9) and into retaining ring groove. Install spacer (10) (used only on models with reduced flow capability), and piston (11) over piston rod (9).

10. Align drive shaft to bearing and install valve plate (7) on housing (36). Thread retaining screws (6) through valve plate and into housing. Torque to the values noted in parts drawing for the unit.

11. Lubricate and install "O" ring (4) in "O" ring groove of piston rod (9). Install gasket (3) on valve plate (7). CAUTION: Position gasket as shown in Figure 2 with teardrop hole pointing toward compensator adjusting screw.

12. Place compensator body (2) over gasket (3) on valve plate (7). Make sure body of compensator and gasket are installed in the correct position for shaft rotation (see Figure 2). Thread retaining screws (1) through compensator into valve plate. Torque screws to the values noted on parts drawings for the unit.

13. Install drive shaft key (33) into drive shaft (31). Make sure key is seated properly.

E. CONVERSIONS

When changing the direction of rotation of an inline hydraulic pump, it will become necessary to change to the respective valve plate for that rotation. If the pump happens to be a compensated type, the compensator must be rotated 180° and the compensator gasket must follow. Consult the appropriate parts drawing listed in Table 1 for the proper valve plate selection.

Hydraulic motors with "V" in the model code require only the rotation of the compensator to change direction. When a change such as this is made, it should be noted by a change in the name plate and any directional arrows as an aid in future identification.

Litho in U. S. A.

20-12-89

ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES SM4 - 20

FLAPPER NOZZLE PILOTED

12

GENERAL DATA

This flapper nozzle piloted servo valve provides the flow modulation, reversibility and fast response required in high performance, closed loop control systems. It is ideally suited for applications needing precise control of position, velocity, acceleration, or force.

FLUID AND TEMPERATURE DATA

Ranging between 150 SSU (Light) and 225 SSU (Medium) at 38°C (100°F). Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400) for hydraulic fluid and temperature recommendations.

FILTRATION

For satisfactory service life of this component, provide full flow system filtration per proposed ISO standard 4406, cleanliness code 15/11. Refer to Section "p", "Filters" and Section "S", "Technical Information" of Vickers Catalog 400 or contact your Vickers representative for further filtration advice. Bypass type pressure filters are not recommended.

WEIGHT

Valve 3.0 kg (2.3 lbs.)

RATINGS

Supply Pressure 210 Bar (3000 PSI)
(345 bar/5000 PSI capability with engineering review.)
Minimum Pressure 14 Bar (200 PSI)
Maximum Flow Rating (@ 69 Bar (1000 PSI) Drop and 5 percent Non Linearity) 57 L/min. (15 GPM)
(See Model Code for other choices.)
Internal Leakage (@ 210 Bar/3000 PSI) Maximum 1.3 L/min. (0.35 GPM)
Operating Temperature -40 to 121°C (250°F)
Filtration Recommended (Full Flow Pressure Line) ISO cleanliness code 15/11.
Hysteresis (Around Null Point) <2 percent
Threshold <1 percent
Pressure Null Shift (Nominal) <2 percent/69 Bar (1000 PSI)
Temperature Null Shift (Nominal) <2 percent/38°C (100°F)
Flow Gain at Null ±50 percent nominal gain/1 percent rated current.
Pressure Gain at Null >25 percent supply press./1 percent rated current.
Seals Fluorocarbon

ACCESSORIES

Name	Description	Part or Model No.
Subplate - Rear Port	SM4M-20-10	682997
Subplate - Side Port	SM4ME-20-10	682998
Bolt Kit BKSD403631	5/16 × 18 UNC 2.00 In. Long, Grade 5 Or Better	255631
Filter Module	SM4FM-20/30-10	686501
Bolt Kit (for use with filter module) BKSA4628	5/16 × 18 UNC 2.75 In. Long, Grade 5 or Better	855421
Adapter to CETOP5	SM4A5-20-10	686619
Flushing Valve	SM4FV-20-10	682999
Cable Connector	MS3106-14S-2S	242123
Cable Clamp	MS3057-6	126058

VICKERS®

VICKERS, INCORPORATED
A TRINOVA COMPANY
Troy, MI 48064

INSTALLATION
DATA

MODEL SERIES
SM4 - 20

3.8 to 57 L/min.
(1.0 TO 15 GPM)
FLOW

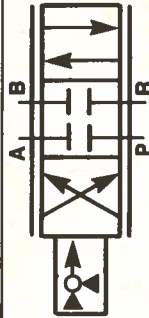
210 BAR (3000 PSI)
SUPPLY PRESSURE

MANIFOLD OR
SUBPLATE
MOUNTING

DWG. NO.
I-519625

SERVO

Revised 9-88



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

SM 4-20 (15)57-20/200-10

1 2 3 4 5 6

1 Servo Valve 5 *Nominal Coil Resistance

2 4-way Flow Direction 20/200 - ohms/mA
30/100 - ohms/mA
80/40 - ohms/mA
200/20 - ohms/mA
300/30 - ohms/mA
1000/10 - ohms/mA
1500/8 - ohms/mA

3 Valve Size

4 *Rated Flow

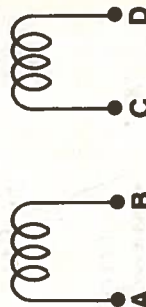
@ 69 bar/1000 PSI Δ P 6 Design Number

(1) 3.8 - (GPM) L/min.
(2.5) 10 - (GPM) L/min.
(5) 19 - (GPM) L/min.
(10) 38 - (GPM) L/min.
(15) 57 - (GPM) L/min.

Subject to change. Installation dimensions remain as shown for designs 10 through 19.
* Other flow and coil ratings available on request.

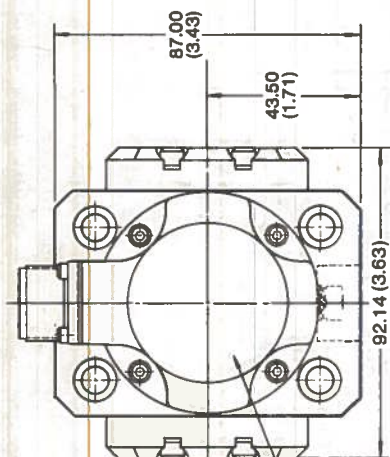
TORQUE MOTOR COILS

Coil Resistance	Rated Circuit Current (Parallel, Diff., or Single Coil)
20	200mA
30	100mA
80	40mA
200	20mA
300	30mA
1000	10mA
1500	8mA

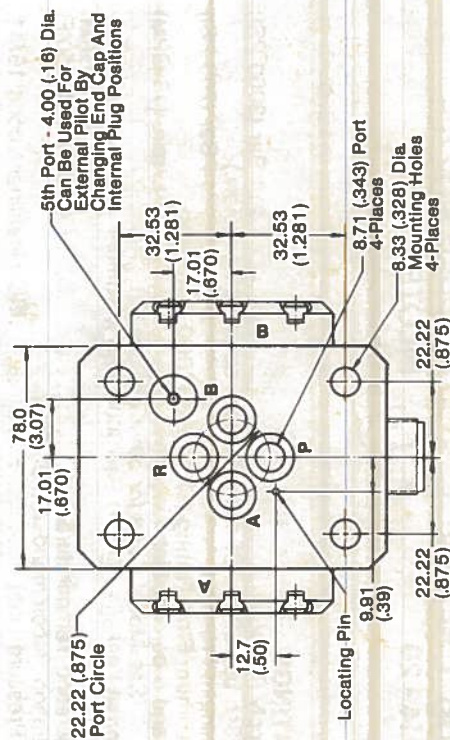
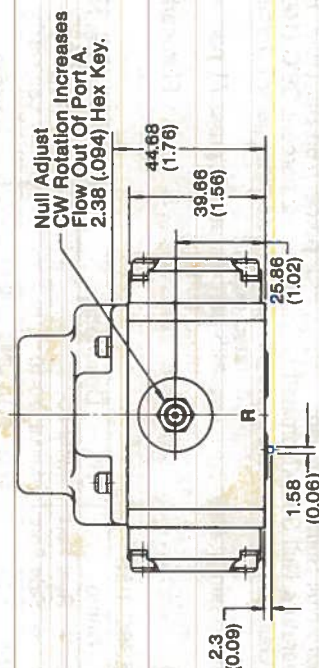
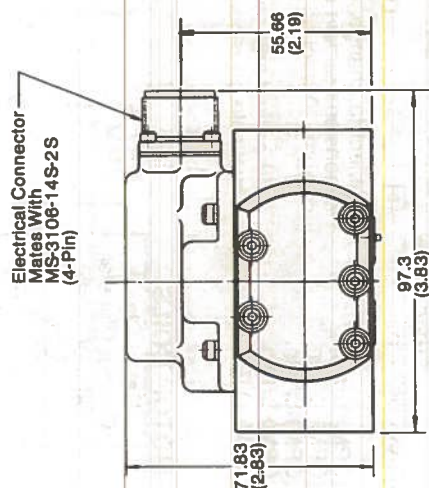


Plus signal to A or C causes flow out of Port B. Plus signal to B or D causes flow out of Port A.

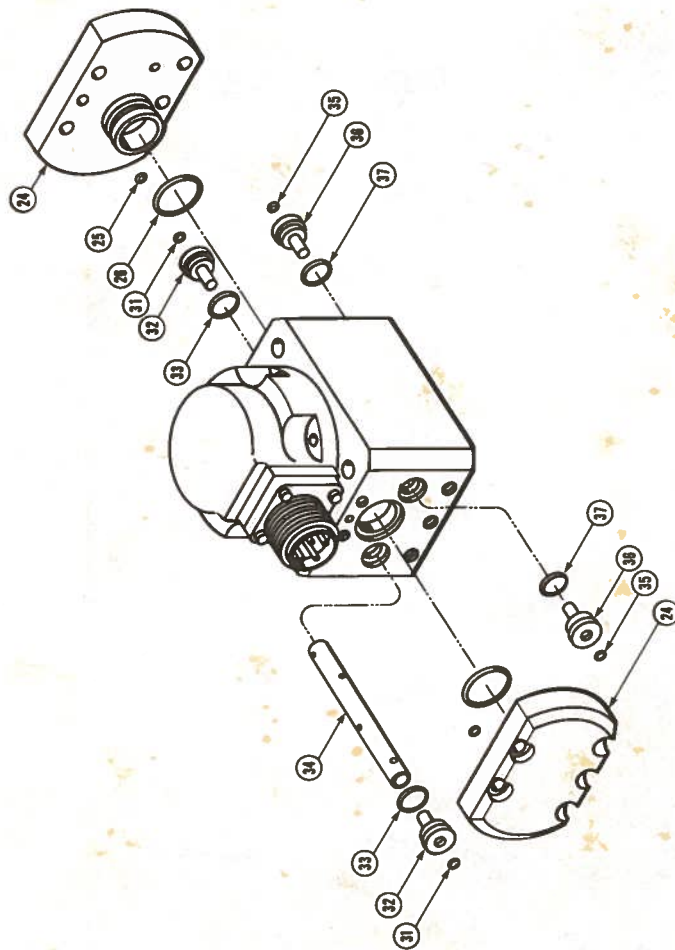
ALL DIMENSIONS SHOWN
ARE IN MILLIMETERS (INCHES)



Cover Can Be Rotated To Locate
Electrical Connector In 4
Different Positions



ACTIVATION OF OPTIONAL 5TH PORT

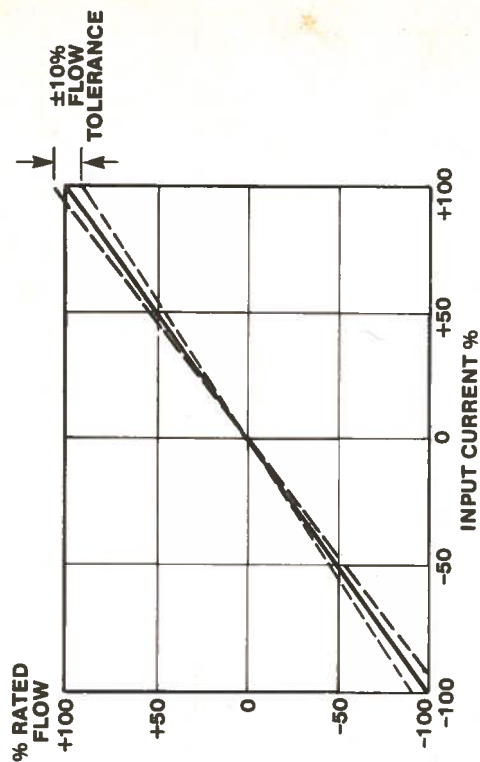


PROCEDURE

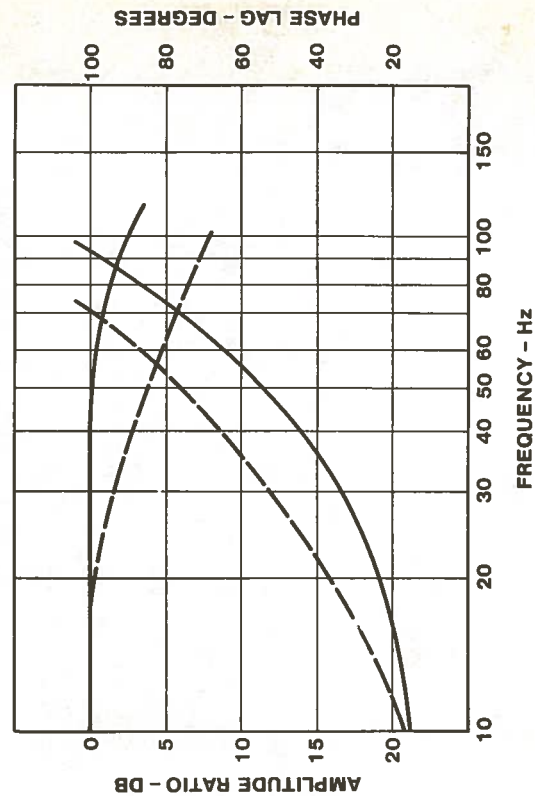
1. Remove end caps (24) (will be relocated to opposite ends of valve in step 5).
2. Remove plug (36) and o-rings (35), (37).
3. Remove orifice (32), filter screen (34) and o-rings (31), (32). Install these items in place of items removed in step 2.
4. Install items removed in step 2 where orifice and filter screen were previously located. Reference step 3.
5. Install valve end caps on the opposite ends of valve from which they were removed. Reference step 1.

THE VALVES 5TH PORT IS NOW ACTIVATED

TYPICAL FLOW/CURRENT RELATIONSHIP



TYPICAL DYNAMIC PERFORMANCE 15 GPM Size, 3000 PSI Supply ±40 Percent Rated Current ±100 Percent Rated Current ---



I-519625-3

Revised 9-88

1000

1000

1000

1000

1000

1000

1000



1000

1000

ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES SM4 - 10

FLAPPER NOZZLE PILOTED

GENERAL DATA

This flapper nozzle piloted servo valve provides the flow modulation, reversibility and fast response required in high performance, closed loop control systems. It is ideally suited for applications needing precise control of position, velocity, acceleration, or force.

FLUID AND TEMPERATURE DATA

Ranging between 150 SSU (Light) and 225 SSU (Medium) at 38°C (100°F). Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400) for hydraulic fluid and temperature recommendations.

FILTRATION

For satisfactory service life of this component, provide full flow system filtration per proposed ISO standard 4406, cleanliness code 15/11. Refer to Section "P", "Filters" and Section "S", "Technical Information" of Vickers Catalog 400 or contact your Vickers representative for further filtration advice. Bypass type pressure filters are not recommended.

WEIGHT

Valve 0.681 kg (1.50 lbs.)

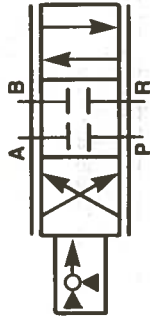
RATINGS

Supply Pressure 210 Bar (3000 PSI)
(345 bar/5000 PSI pressure capability with engineering review.)
Minimum Pressure 14 Bar (200 PSI)
Maximum Flow Rating (@ 69 Bar/1000 PSI Drop and 5 percent Non Linearity) 28 L/min. (7.5 GPM)
(See Model Code for other choices.)
Internal Leakage (@ 210 Bar/3000 PSI) Maximum 1.3 L/min.
(0.35 GPM)
Operating Temperature -40 to 121°C (250°F)
Filtration Recommended (Full Flow Pressure Line) ISO cleanliness code 15/11.
Hysteresis (Around Null Point) < 2 percent
Threshold < 1 percent
Pressure Null Shift (Nominal) < 2 percent/69 Bar (1000 PSI)
Temperature Null Shift (Nominal) < 2 percent/38°C (100°F)
Flow Gain at Null ±50 percent nominal gain/1 percent rated current.
Pressure Gain at Null > 25 percent supply press./1 percent rated current
Seals Fluorocarbon

ACCESSORIES

Name	Description	Part or Model No.
Subplate - Rear Port	SM4M-10-10	682142
Subplate - Side Port	SM4ME-10-10	682143
Bolt Kit BKSC4629	1/4 X 20 UNC 2.25 In. Long, Grade 5 Or Better	255629
Adapter to CETOP3	SM4A3-10-10	686617
Flushing Valve	SM4FV-15-10	633231
Cable Connector	MS3106-14S-2S	242123
Cable Clamp	MS3057-6	126058

STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS



MODEL CODE

SM 4 - 10 (7.5)28 - 20/200 - 10

1 2 3 4 5 6

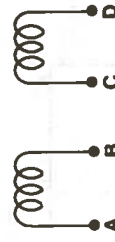
1	Servo Valve	5	Nominal Coil Resistance
2	Flow Direction		20/200 - ohms/mA 30/100 - ohms/mA 80/40 - ohms/mA 200/20 - ohms/mA 300/30 - ohms/mA 1000/10 - ohms/mA 1500/8 - ohms/mA
3	Valve Size		
4	*Rated Flow		
	@ 69 bar/1000 PSI Δ P	6	Design Number

Subject to change. Installation dimensions remain as shown for design numbers 10 through 19.

* Other flow and coil ratings available on request.

TORQUE MOTOR COILS

Coil Resistance	Rated Circuit Current (Parallel, Diff., or Single Coil)
20	200mA
30	100mA
80	40mA
200	20mA
300	30mA
1000	10mA
1500	8mA



Plus signal to A or C causes flow out of Port B. Plus signal to B or D causes flow out of Port A.

VICKERS

VICKERS, INCORPORATED
A TRINOVA COMPANY
Troy, MI 48064

INSTALLATION
DATA

MODEL SERIES
SM4 - 10

3.8 to 28 L/min.
(1.0 TO 7.5 GPM)
FLOW

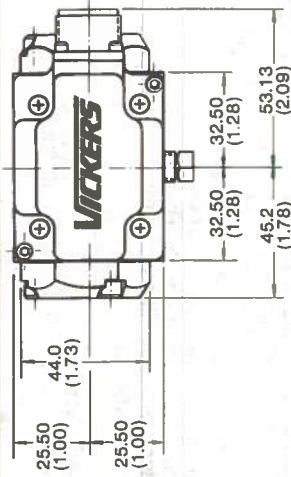
210 Bar (3000 PSI)
SUPPLY PRESSURE

MANIFOLD
OR SUBPLATE
MOUNTING

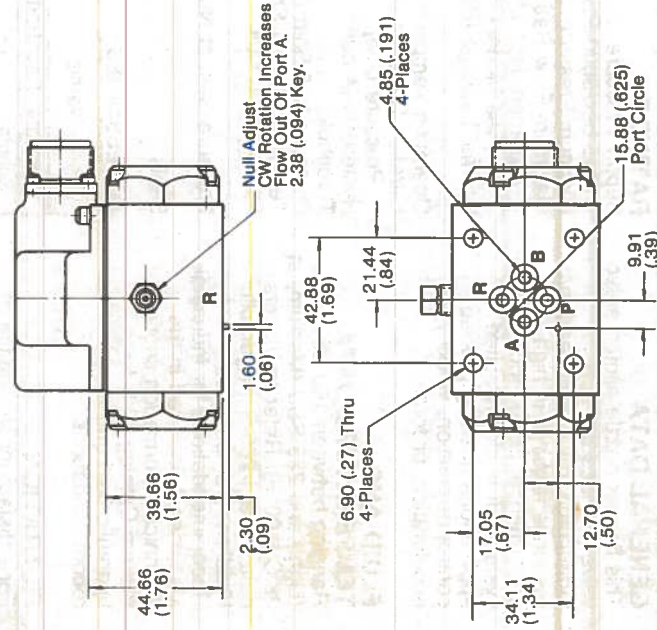
DWG. NO.
I-519610

SERVO

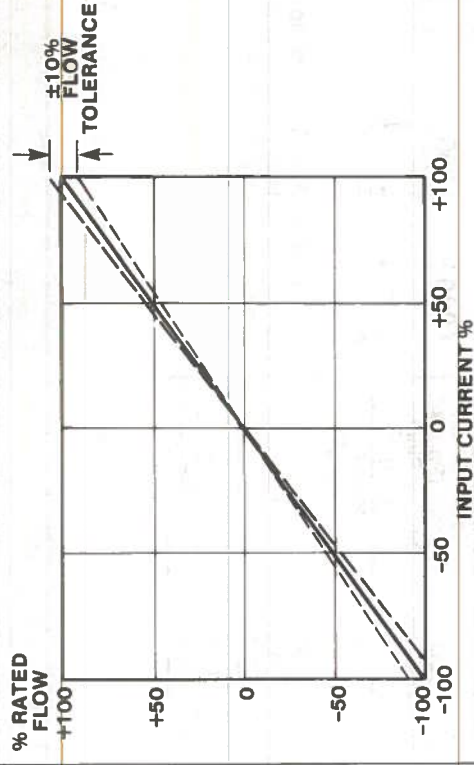
Revised 9-88



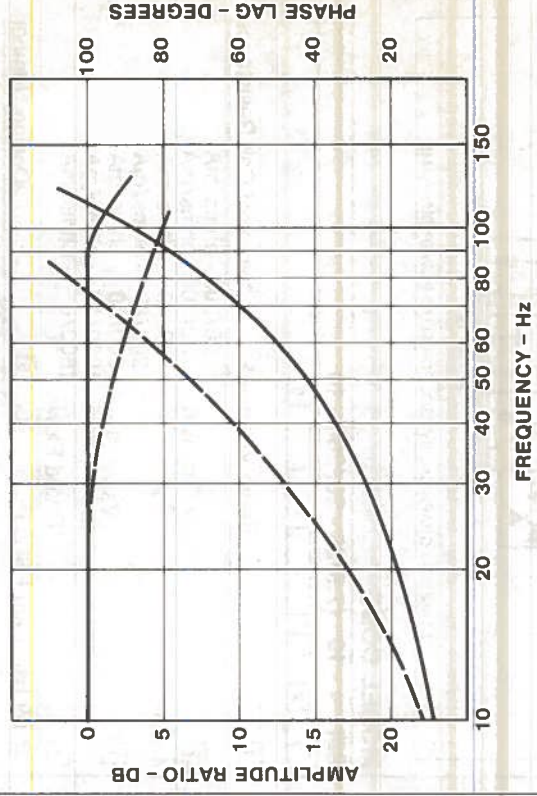
ALL DIMENSIONS SHOWN
ARE IN MILLIMETERS (INCHES)



TYPICAL FLOW/CURRENT RELATIONSHIP



TYPICAL DYNAMIC PERFORMANCE 10 GPM Size, 3000 PSI Supply ±40 Percent Rated Current ±100 Percent Rated Current ---



ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES SM4 - 15

FLAPPER NOZZLE PILOTED

GENERAL DATA

This flapper nozzle piloted servo valve provides the flow modulation, reversibility and fast response required in high performance, closed loop control systems. It is ideally suited for applications needing precise control of position, velocity, acceleration, or force.

FLUID AND TEMPERATURE DATA

Ranging between 150 SSU (Light) and 225 SSU (Medium) at 38°C (100°F). Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400) for hydraulic fluid and temperature recommendations.

FILTRATION

For satisfactory service life of this component, provide full flow system filtration per proposed ISO standard 4406 cleanliness code 15/11. Refer to Section "P", "Filters", and Section "S", "Technical Information" of Vickers Catalog 400 or contact your Vickers representative for further filtration advice. Bypass type pressure filters are not recommended.

WEIGHT

Valve 0.681 kg (1.50 lbs.)

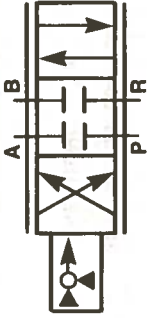
RATINGS

Supply Pressure 210 Bar (3000 PSI)
(345 Bar/5000 PSI capability with engineering review.)
Minimum Pressure 14 Bar (200 PSI)
Maximum Flow Rating (@ 69 Bar/1000 PSI Drop and 5 Percent Non Linearity) 45 L/min. (12 GPM)
(See Model Code for other choices.)
Internal Leakage (@ 3000 PSI) Maximum 1.3 L/min. (0.35 GPM)
Operating Temperature -40 to 121°C (250°F)
Filtration Recommended (Full Flow Pressure Line) ISO cleanliness code 15/11.
Hysteresis (Around Null Point) <2 percent
Threshold <1 percent
Pressure Null Shift (Nominal) <2 percent/69 Bar (1000 PSI)
Temperature Null Shift (Nominal) <2 percent/38°C (100°F)
Flow Gain at Null ±50 percent nominal gain/1 percent rated current.
Pressure Gain at Null >25 percent supply press./1 percent rated current.

Seals Fluorocarbon

ACCESSORIES

Name	Description	Part or Model No.
Adapter	SM4A-15-M76-10	635670
Subplate - Rear Port	SM4M-15-10	989027
Subplate - Side Port	SM4ME-15-10	989028
Bolt Kit BKSC4629	1/4 X 20 UNC 2.25 In. Long. Grade 5 Or Better	255629
Adapter to CETOP3	SM4A3-15-10	686519
Adapter to CETOP5	SM4A5-15-10	686521
Flushing Valve	SM4FV-15-10	633231
Cable Connector	MS3106-14S-2S	242123
Cable Clamp	MS3057-6	126058



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

SM 4-15 (12)45-20/200-10

1 2 3 4 5 6

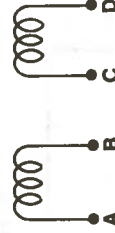
1	Servo Valve	5	*Nominal Coil Resistance
2	Flow Direction	20/200 - ohms/mA	
3	Valve Size	30/100 - ohms/mA	
4	*Rated Flow	80/40 - ohms/mA	
@ 69 bar/1000 PSI Δ P		200/20 - ohms/mA	
		300/30 - ohms/mA	
		1000/10 - ohms/mA	
		1500/8 - ohms/mA	
6	Design Number		

Subject to change. Installation dimensions remain as shown for designs 10 through 19.

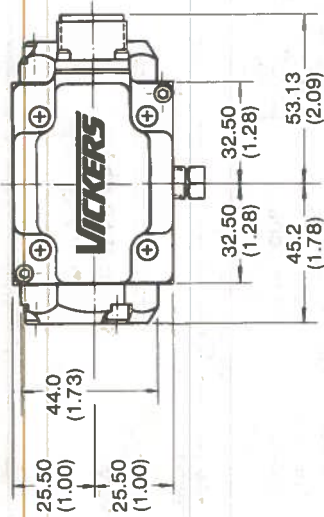
* Other flow and coil ratings available on request.

TORQUE MOTOR COILS

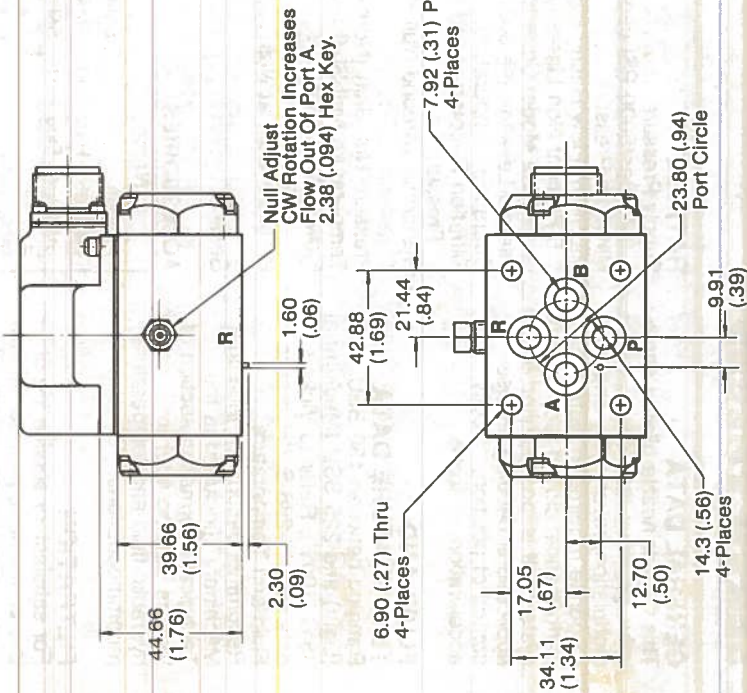
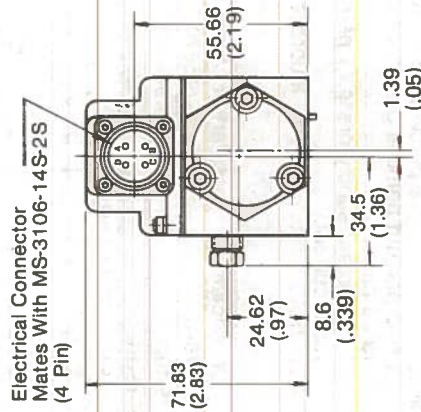
Coil Resistance	Rated Circuit Current (Parallel, Diff., or Single Coil)
20	200mA
30	100mA
80	40mA
200	20mA
300	30mA
1000	10mA
1500	8mA



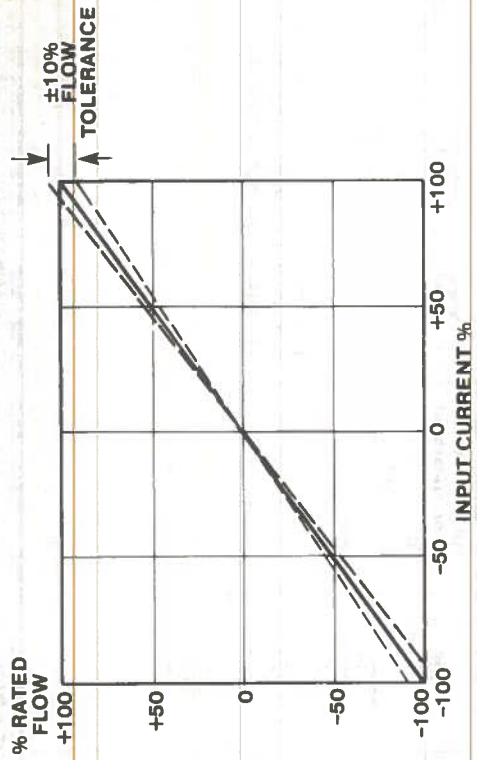
Plus signal to A or C causes flow out of Port B. Plus signal to B or D causes flow out of Port A.



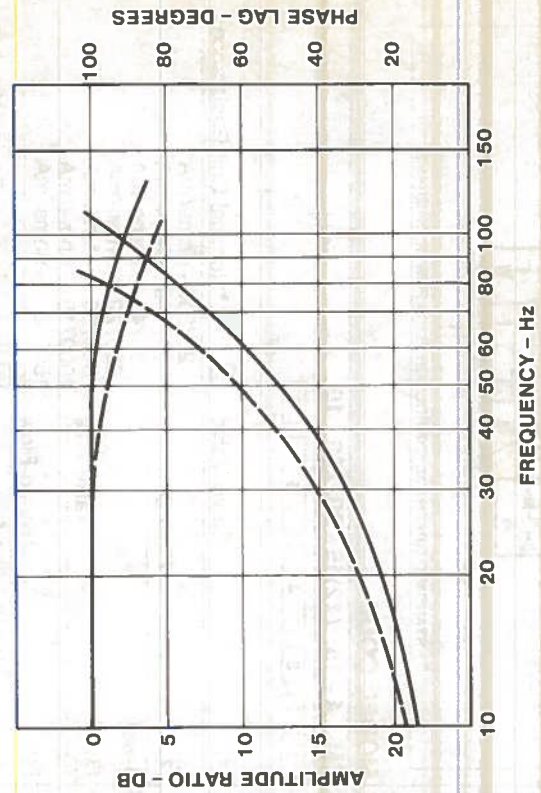
ALL DIMENSIONS SHOWN
ARE IN MILLIMETERS (INCHES)



TYPICAL FLOW/CURRENT RELATIONSHIP



TYPICAL DYNAMIC PERFORMANCE 10 GPM Size, 3000 PSI Supply ±40 Percent Rated Current ±100 Percent Rated Current - - -



ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES SM4 - 40

FLAPPER NOZZLE PILOTED

GENERAL DATA

This flapper nozzle piloted servo valve provides the flow modulation, reversibility and fast response required in high performance, closed loop control systems. It is ideally suited for applications needing precise control of position, velocity, acceleration, or force.

FLUIDS AND TEMPERATURE DATA

Ranging between 150 SSU (Light) and 225 SSU (Medium) at 38° (100°F.) Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400) for hydraulic fluid and temperature recommendations.

FILTRATION

For satisfactory service life of this component, provide full flow system filtration per proposed ISO standard 4406, cleanliness code 15/11. Refer to Section "P", "Filters" and Section "S", "Technical Information" of Vickers Catalog 400 or contact your Vickers representative for further filtration advice. Bypass type pressure filters are not recommended.

WEIGHT

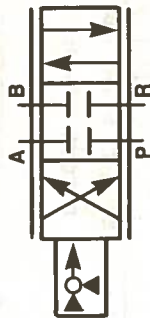
Valve 2.8 kg (6.2 lbs.)

RATINGS

Supply Pressure 210 Bar (3000 PSI)
(345 Bar/5000 PSI capability with engineering review.)
Minimum Pressure 14 Bar (200 PSI)
Maximum Flow Rating (@ 69 Bar/1000 PSI Drop and 5 Percent Non Linearity) 151 L/min. (40 GPM)
(See Model Code for other choices.)
Internal Leakage (@ 210 Bar/3000 PSI) Maximum 2.27 L/min. (0.6 GPM)
Operating Temperature -40 to 121°C (250°F)
Filtration Recommended (Full Flow Pressure Line) ISO cleanliness code 15/11.
Hysteresis (Around Null Point) <3 percent
Threshold <1 percent
Pressure Null Shift (Nominal) <2 percent/69 Bar (1000 PSI)
Temperature Null Shift (Nominal) <2 percent/38°C (100°F)
Flow Gain at Null ±50 percent nominal gain/1 percent rated current.
Pressure Gain at Null >25 percent supply press./1 percent rated current.
Seals Fluorocarbon

ACCESSORIES

Name	Description	Part or Model No.
Subplate - Rear Port	SM4M-40-10	989025
Subplate - Side Port	SM4ME-40-10	989026
Bolt Kit BKXL03663	5/16 X 18 UNC 3 In. Long. Grade 5 Or Better	255644
Flushing Valve	SM4FV-40-10	635681
Cable Connector	MS3106-14S-2S	242123
Cable Clamp	MS3057-6	126058



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

SM 4 - 40 - (20)76 - 20/200 - 10

1 2 3 4 5 6

1 Servo Valve 5

2 Flow Direction

3 Valve Size

4 *Rated Flow

@ 69 bar/1000 PSI Δ P

(20) 76 - (GPM) L/min.

(25) 95 - (GPM) L/min.

(30) 113 - (GPM) L/min.

(35) 132 - (GPM) L/min.

(40) 151

5 *Nominal Coil Resistance

20/200 - ohms/mA

30/100 - ohms/mA

80/40 - ohms/mA

200/20 - ohms/mA

300/30 - ohms/mA

1000/10 - ohms/mA

1500/8 - ohms/mA

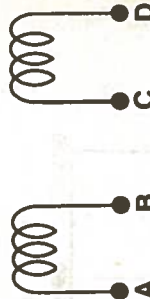
6 Design Number

Subject to change. Installation dimensions remain as shown for design numbers 10 through 19.

* Other flow and coil ratings available on request.

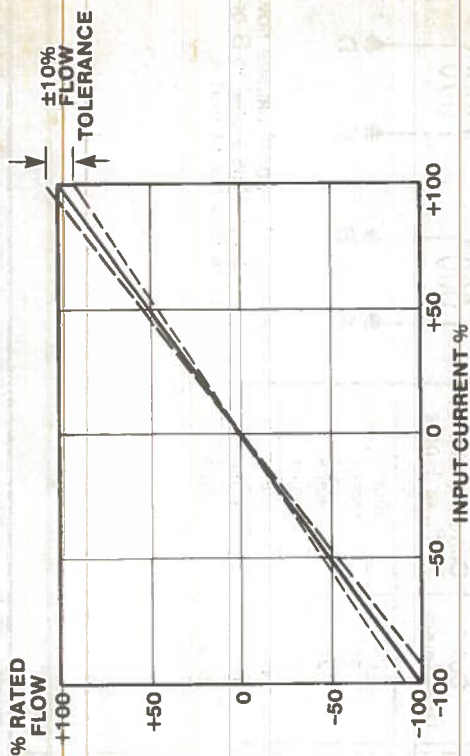
TORQUE MOTOR COILS

Coil Resistance	Rated Circuit Current (Parallel, Diff., or Single Coil)
20	200mA
30	100mA
80	40mA
200	20mA
300	30mA
1000	10mA
1500	8mA

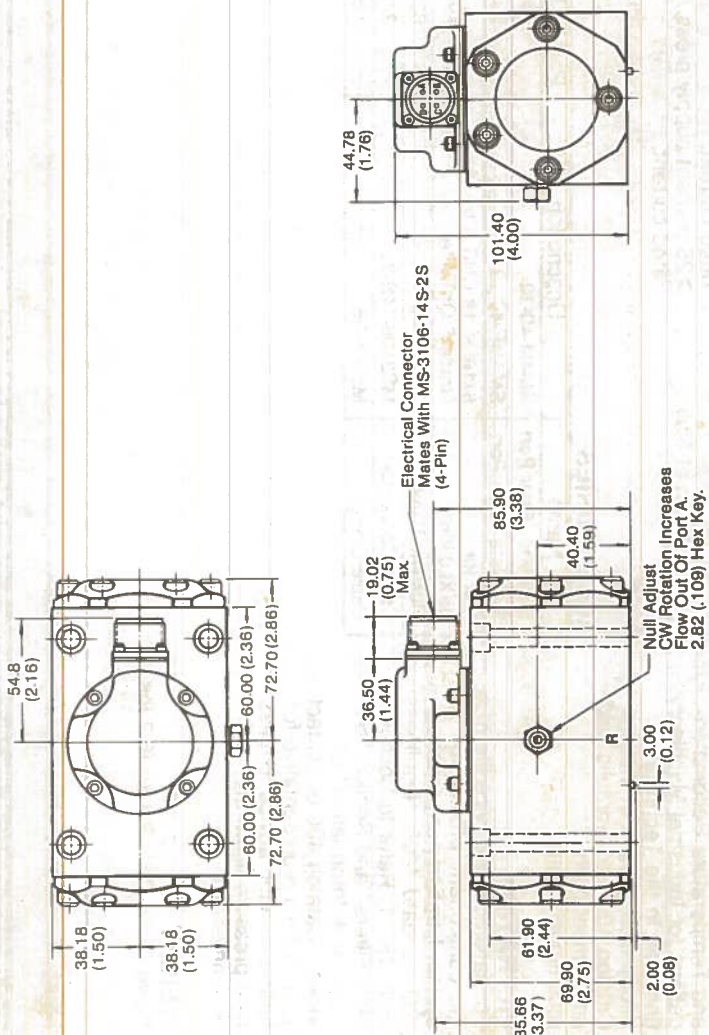
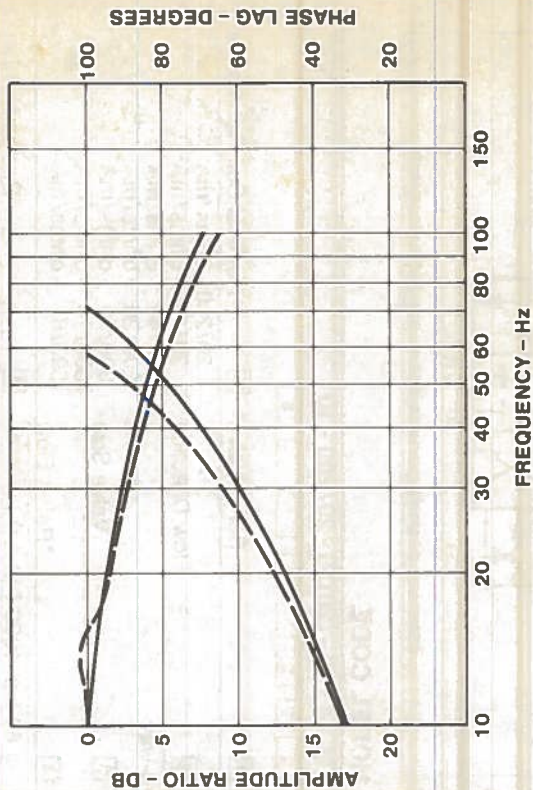


Plus signal to A or C causes flow out of Port B. Plus signal to B or D causes flow out of Port A.

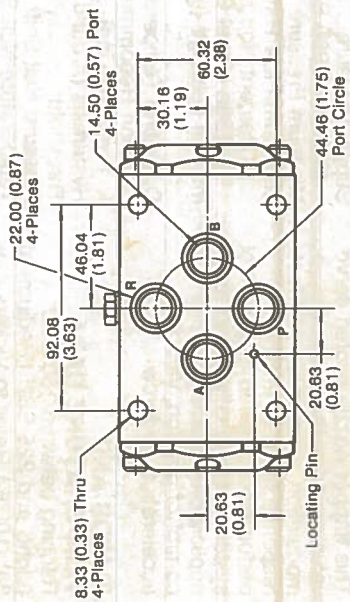
TYPICAL FLOW/CURRENT RELATIONSHIP



TYPICAL DYNAMIC PERFORMANCE 20 GPM Size, 3000 PSI Supply ±40 Percent Rated Current ±100 Percent Rated Current - - -



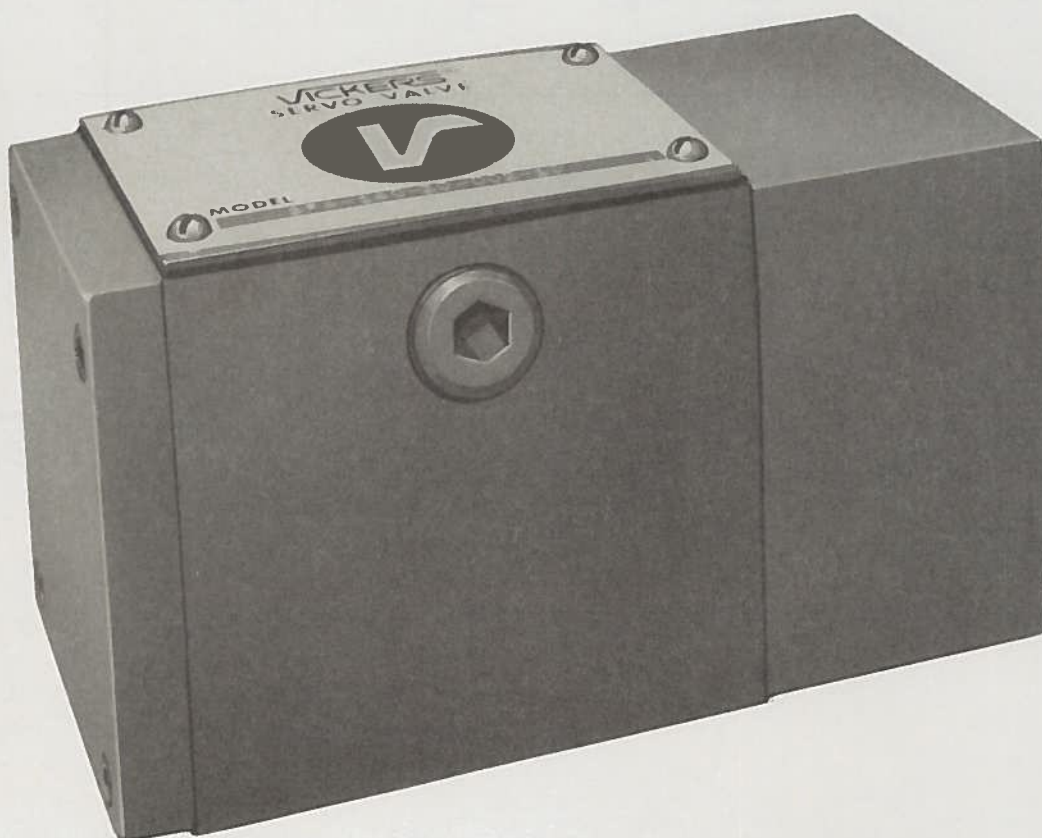
ALL DIMENSIONS SHOWN
ARE IN MILLIMETERS (INCHES)



Overhaul Manual

**TWO-STAGE
FLAPPER TYPE
SERVO VALVE**

**SF4-100-30-002-10
SF4-140-20-002-10**



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

Revised 9-1-87

I-3063-S

MODEL CODE BREAKDOWN

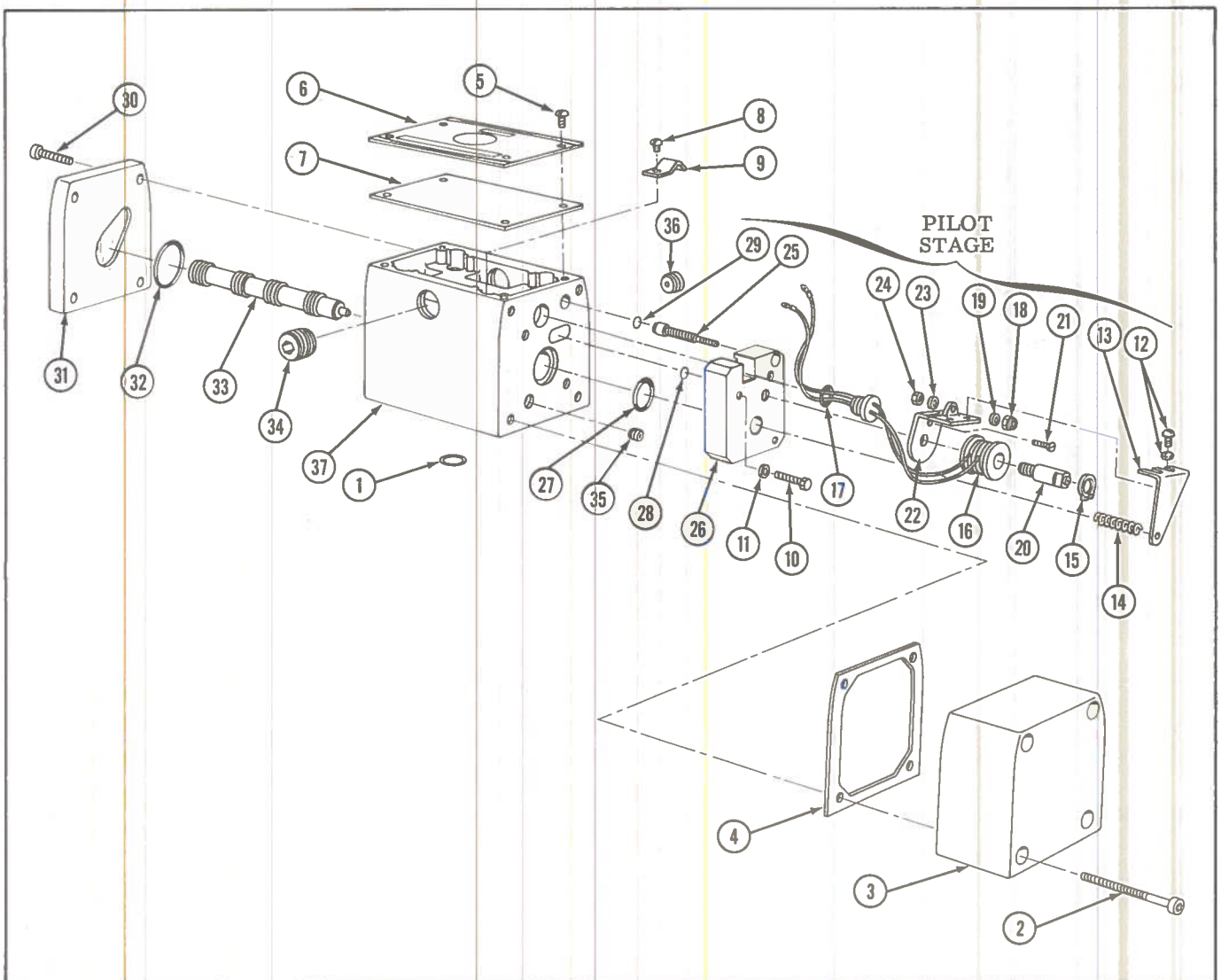
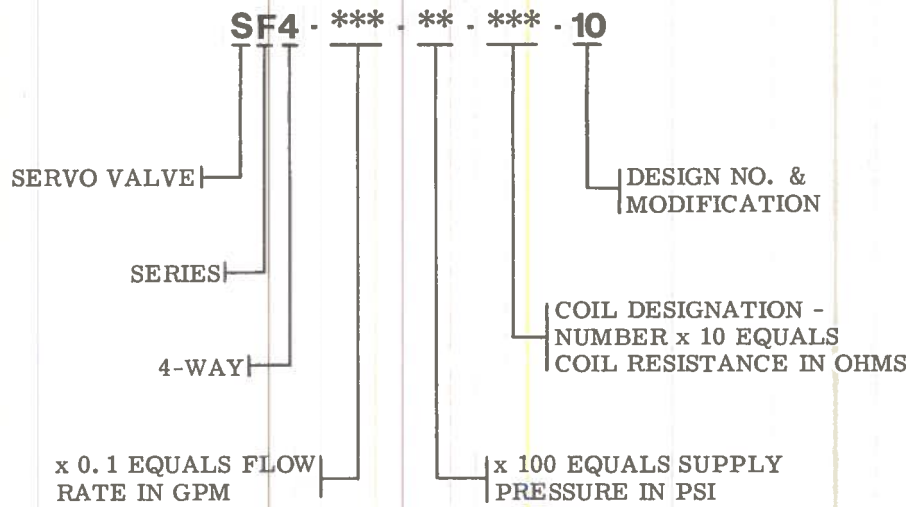


Figure 1. Exploded View of Servo Valve

LEGEND FOR FIGURES 1 THRU 4			
INDEX NUMBER	PART NUMBER	NAME	QTY
1	▲199811	"O" Ring	5
2	207892	Screw	4
3	376706	Cover	1
4	▲323926	Gasket	1
5	174638	Screw	4
6	-	Nameplate	1
7	▲286122	Gasket	1
8	353860	Screw	1
9	353859	Clamp	1
10	42590	Screw	2
11	68904	Washer	2
12	344966	Screw and Lock Washer S/A	2
13	323931	Armature Flapper	1
14	351042	Spring	1
15	102671	Retaining Ring	1
16	346773	Coil & Seal	1
17	▲154006	"O" Ring	1
18	352641	Lock Nut	1
19	233106	Washer	1
20	351437	Nozzle (SF4-100-30-002-10)	1
20	343410	Nozzle (SF4-140-20-002-10)	1
21	112201	Screw	1
22	323933	Frame	1
23	233106	Washer	1
24	200345	Nut	1
25	351436	Adjusting Screw	1
26	343414	Adapter Plate S/A	1
27	▲157515	"O" Ring	1
28	▲154139	"O" Ring	1
29	▲154004	"O" Ring	1
30	11012	Screw	4
31	323923	Cover	1
32	▲154140	"O" Ring	1
33	942070	Spool S/A (SF4-140-20-002-10)	1
33	942320	Spool S/A (SF4-100-30-002-10)	1
34	64765	Plug	1
35	16794	Orifice Plug	1
36	7074	Plug	1
37	323921	Body	1
▲ 919529 SEAL KIT			

SECTION I - INTRODUCTION

1-1. REFERENCE MATERIAL. Installation dimensions and operating specifications are not contained in this manual. Refer to installation drawing 501170 for that information.

1-2. KITS. A gasket kit is available for this servo valve. It is recommended that new "O" rings and gaskets be used during overhaul. The part number of the kit is 919529.

SECTION II - OVERHAUL

2-1. UNIT REMOVAL.

WARNING

Turn off all electrical power and relieve hydraulic pressure. Block any load that could generate pressure.

- A. Remove the unit from the system.
- B. Cap all system openings to prevent entry of dirt.

2-2. SPECIAL TOOLS. The following special tools are needed:

1. Torque wrench rated in LB. IN.
2. Flushing plate. Refer to figure 6 for dimensions.
3. 0-500 milliammeter.

2-3. IMPROVISED TOOLS. No improvised tools are required for overhaul.

2-4. DISASSEMBLY. Periodic maintenance of the valve will generally not require disassembly to the

extent described here. However, the sequence can also be used as a guide for partial disassembly. In general, disassembly is accomplished in the item number sequence shown on Figure 1. Special procedures are included in the following steps:

- A. Thoroughly clean the exterior of the valve.
- B. The valve is full of fluid, so hold it over a container when the cover (3, Figure 1) is removed.
- C. Remove parts (1) thru (11) according to sequence.

D. Remove the pilot stage parts (12) thru (26) as a unit by pulling the adapter (26) from the main stage body (37); at the same time, push the coil connector from the body. See Figure 4. Disassemble the pilot stage according to numerical sequence in Figure 1.

- E. Remove parts (27) thru (37).

2-5. **CLEANING.** All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of servo valves makes this

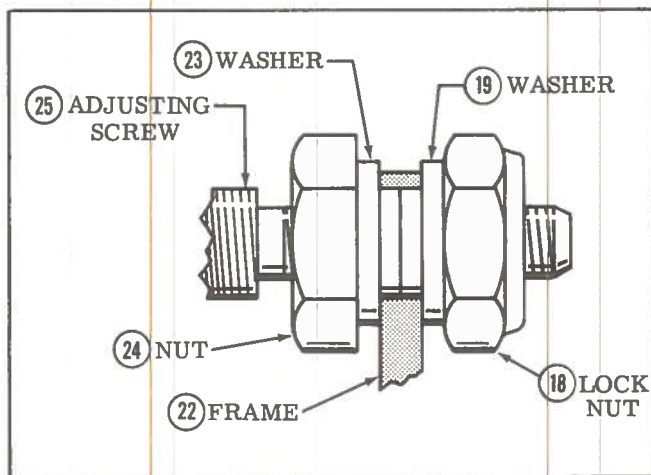


Figure 2. Location of Adjustment Screw Nuts and Washers

requirement more stringent than usual. Use a commercial solvent which is compatible with the system fluid to clean the parts. Compressed air may be used in cleaning the valve but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning the spool orifices and body passages.

2-6. **INSPECTION, REPAIR, AND REPLACEMENT.** Check that all internal passages are clean and unobstructed. Examine all mating surfaces for nicks and burrs. Check the condition of threaded parts and threaded holes. Check the retaining ring (14). Minor burrs can be removed with an India stone.

CAUTION

The spool (33) must not have the land edges broken with the stone. They are held to a very close tolerance.

- A. Make sure that the 0.020 hole in the side of the spool (33) and the 0.030 hole in the orifice plug which is screwed in the end of the spool are completely open. (See Figure 5.) The orifice plug in the end of the spool may have to be removed to clean

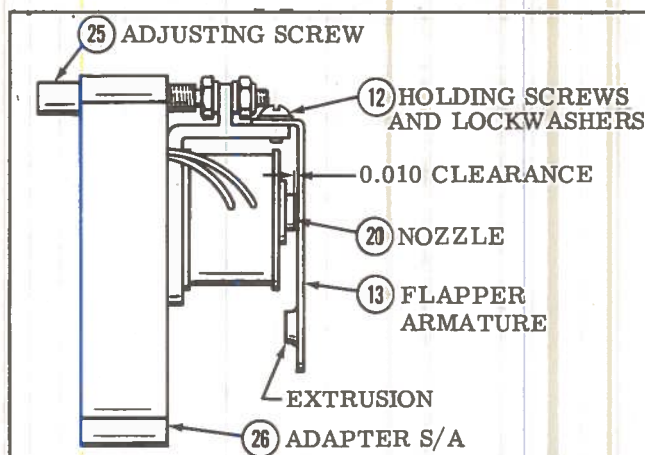


Figure 3. Pilot Stage Servo Valve Adjustment Locations

out contaminants that have gathered inside the spool.

- B. Check the 0.060 hole in the nozzle (20).
- C. Check frame (22) for cracks or distortion.
- D. Check the feedback spring (14) for distortion.
- E. Make a continuity check of the coil and seal subassembly (16). Resistance values should range from 18 to 22 ohms. This test is superficial but a more rigorous test requires special equipment.
- F. Check the adapter (26) and spool mating surfaces. Insert the spool into the adapter and rotate the spool. The spool must not bind in any position.

2-7. **ASSEMBLY.** Replace the gaskets and "O" rings with those supplied in the gasket kit. Apply a light film of clean system fluid to the parts prior to installing them. This will make assembly easier and provide initial lubrication. Special procedures are included in the following steps:

- A. Assemble parts (37) thru (35). See Figure 1.
- B. Assemble the pilot stage portion of the valve as follows:
 1. Assemble parts (26), (22), (21) and (20).
 2. Install adjusting screw (25) thru the adapter (26), attach standard nut (24) and washer (23) and turn the nut on until it bottoms against the shoulder of the adjusting screw. See Figures 2 and 3.
 3. Turn the adjusting screw (25) thru the hole on the frame (22) far enough to attach the other washer (19) and lock nut (18).
 4. Turn one of the nuts until it contacts the frame, then tighten the other nut. See Figure 2.

NOTE

After tightening the nuts (18) and (24) against their respective washers, the adjusting screw (25) should turn free and have no end play between the screw and the frame (22).

- 5. Assemble parts (17) thru (15). See Figure 1.

CAUTION

Be careful when installing flapper armature (13). The securing screws (12) extend thru the frame (22) and could break the insulation on the coil. See Figure 3.

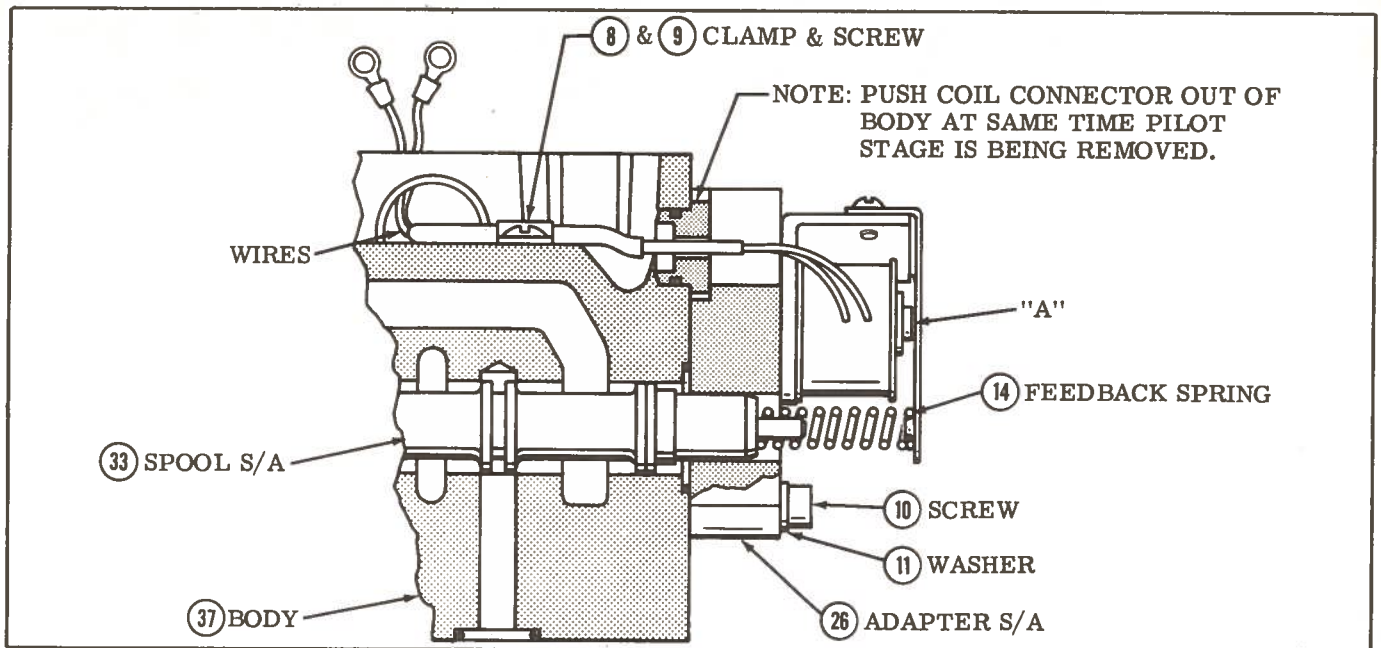


Figure 4. Sectional View

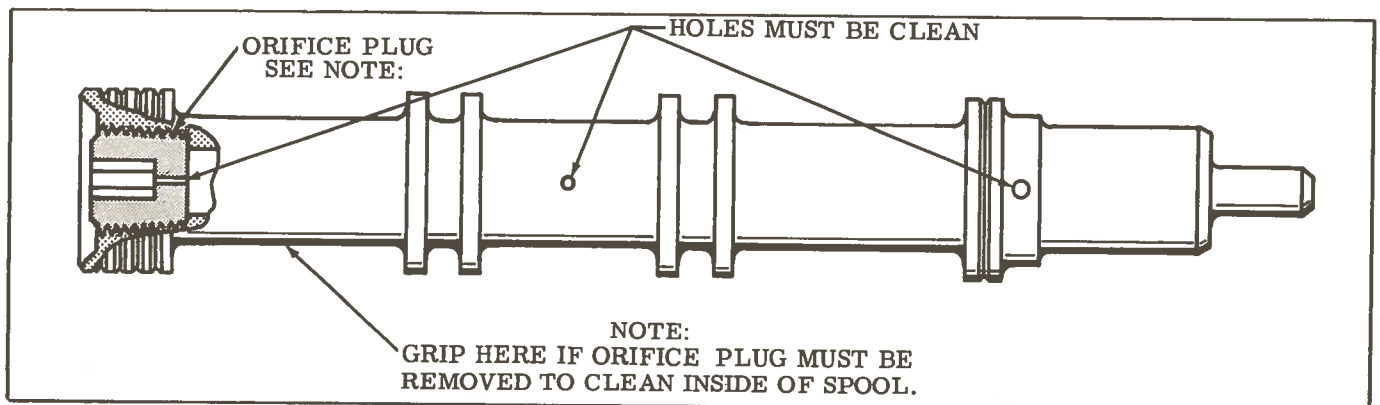


Figure 5. Spool Subassembly

6. Place a 0.010 shim between the flapper armature (13) and the nozzle (20) while tightening the two holding screws and lockwashers (12). See Figure 3.

NOTE

The flapper armature must be square with the nozzle when the operation is completed and have a 0.010 clearance. A change in the setting of the adjustment screw (25) may be required during this procedure to keep the flapper armature square with the nozzle.

C. Install "O" ring parts (29) thru (27) into valve body (37).

D. Insert spool subassembly (33) into body (37). The small end of the spool must extend from the valve approximately one inch. Assemble the pilot stage (adapter subassembly (26)) over the spool for alignment purposes. Guide coil wires thru body hole and align the coil connector with body hole while installing. See Figure 4. Tighten the adapter holding screws (10) and washers (11) alternately until the pilot stage is flush against the valve.

E. Check spool to see that it doesn't bind in the adapter (26) then torque the screws to 16-18 LB. IN. Recheck for binding.

F. Assemble the feedback spring (14) to the flapper armature by twisting the spring over the extrusion until the spring is tight against the flapper armature. Use a twisting motion only, lateral force against the flapper armature may bend it. See Figure 4.

G. Assemble parts (34) and (32) thru (30).

H. Turn adjusting screw (25) until light can just be seen between the flapper and orifice, point "A", Figure 4. This is a preliminary null adjustment.

I. Assemble clamp (9) and screw (8) over the wire. Route the wire ends thru the hole to the outside of the valve. See Figure 4.

NOTE

The name plate, gasket, and screws, parts (7) thru (5), should not be installed at this time since a final null adjustment must be made before normal operation can begin.

J. Install parts (4) thru (1). Torque screws (2) to 16-18 LB. IN.

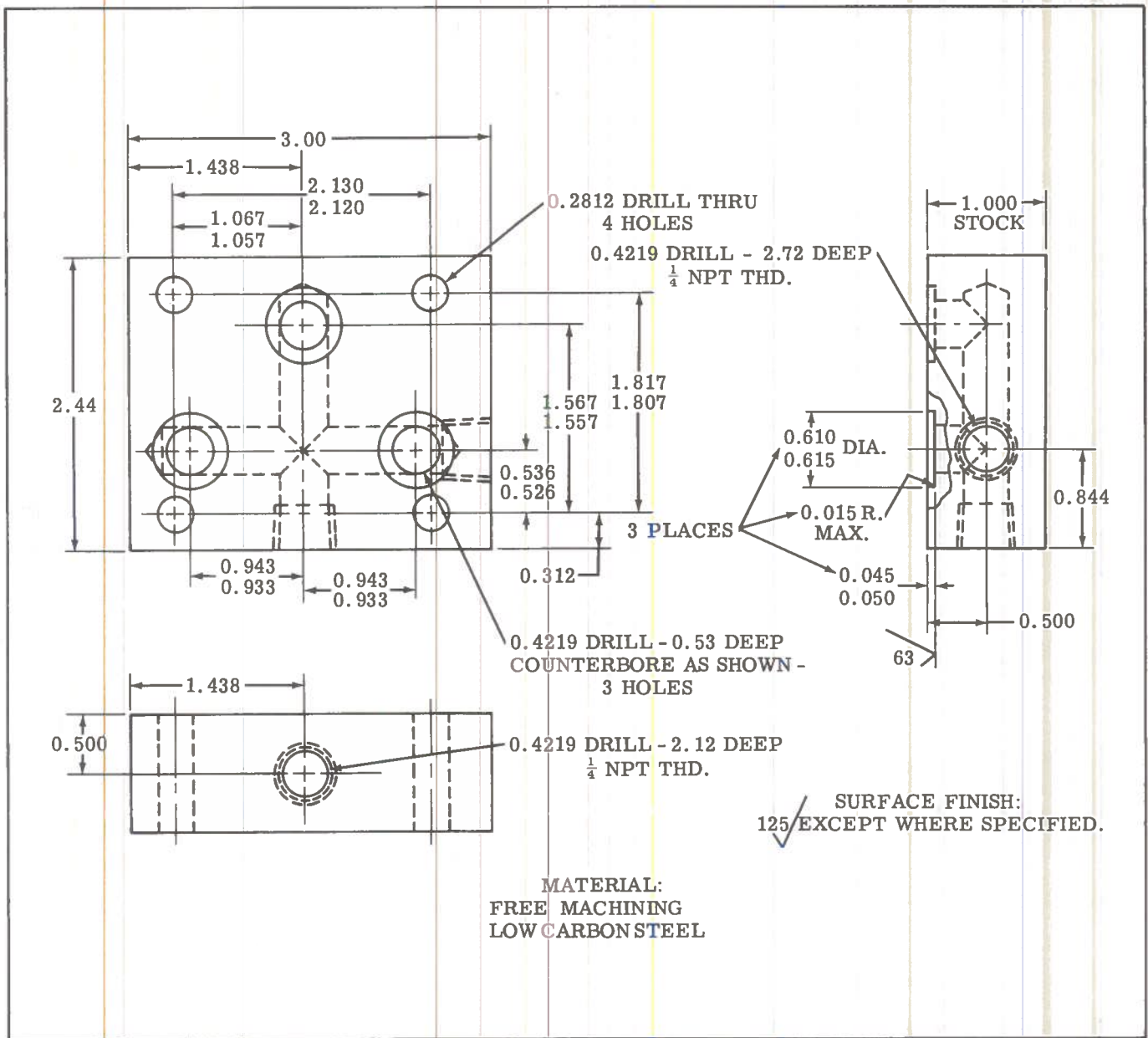


Figure 6. Flushing Plate

2-8. UNIT INSTALLATION. Flush the system through 10 micron full flow filters prior to installing the servovalve. A flushing plate can be manufactured. (See Figure 6.) The plate passes the fluid directly to the tank port. Continue flushing until new filters show no sign of contamination. It may be necessary to

change the system fluid. If so, filter the new fluid as it is poured into the reservoir and then flush the system as described above. After the system is flushed, remove the flushing plate and install the servo valve. Torque the mounting screws to a maximum of 112 LB. IN.

SECTION III - TEST PROCEDURE

3-1. TEST.

A. Utilize your present control system to test the servo valve as follows:

CAUTION

Check polarity of 0-500 milliammeter with system polarity prior to installation to prevent meter damage.

1. Connect meter in system according to Figure 7.
2. Adjust appropriate system command control until a reading of 190 milliamps is observed on meter.
3. Energize the hydraulic system and adjust for hydraulic null (no movement of hydraulic motor or cylinder) with adjustment screw (25). See Figure 1.
4. Slowly vary the system command control so that current shown on the milliammeter varies from 0-400 milliamps. A smooth transition from zero to maximum flow should occur both sides of center

(null) position. Erratic movement may indicate that the servo valve spool is sticking.

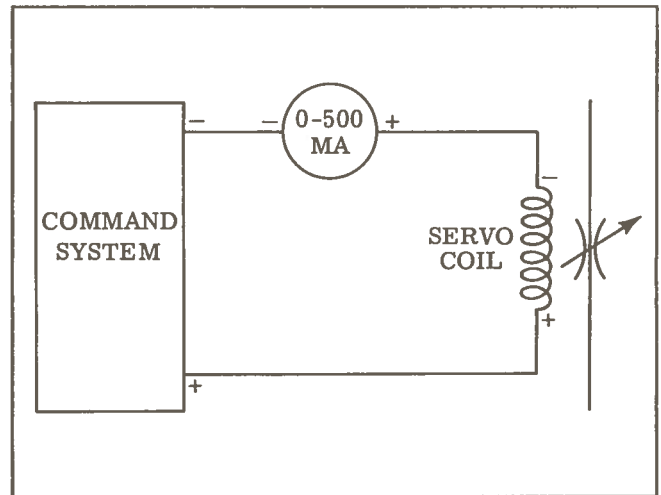


Figure 7. Servo Test Wiring Circuit

Litho in U. S. A.

ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES SF4

TWO-STAGE FLAPPER NOZZLE TYPE

GENERAL DATA

This two-stage flapper nozzle type servo valve, available in ratings of 10 GPM, 3000 PSI supply and 14 GPM, 2000 PSI supply, provides the flow modulation and reversibility required for fast and precise closed loop control of position, velocity and acceleration. It has a single coil requiring a null current of 200 mA and a control current of ± 200 mA about null. Polarity has no effect on valve operation. See drawings 521540 and 519720 for power supply and amplifier data.

APPLICATION GUIDANCE

Tank Connection

The tank connection must be piped independently and directly to the reservoir at atmospheric pressure through a surge-free drain line to avoid valve malfunction or actuator cover failure.

FLUIDS AND TEMPERATURE DATA

Petroleum base ranging between 150 SSU (Light) and 225 SSU (Medium) at 100°F. Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400) for hydraulic fluid and temperature recommendations.

RATINGS

Supply Pressure See model code.
Minimum Pressure 400 PSI
Control Pressure Internal
Flow Rating See model code.
Quiescent Flow (@ 1000 PSI) < 1.0 GPM.
Operating Temperature
 Nominal 120°F
 Maximum 150°F
Filtration Recommended (Full Flow Pressure Line) ISO cleanliness code 15/11
Dither, Required For Optimum Performance 50-60 Hz
Hysteresis (Around Null Point) < 2 percent with dither.
Null Current (Nominal) 200 mA
Operating Current .. ± 200 mA about 200 mA null (0-400 mA range).
Power Required 3.2 watts
Coil Resistance (Nominal) 20 ohms
Pressure Null Shift (Nominal) 035 mA/PSI
Temperature Null Shift (Nominal) 0.25 mA/°F
Deadband Around Null None
Gain Slope At Null (Nominal) 08 GPM/mA
Null Pressure Gain (Nominal):
 SF4-100-30 600 PSI/mA
 SF4-140-20 350 PSI/mA

FILTRATION

For satisfactory service life of this component, provide full flow system filtration. Filter selections from Vickers OFP, OFR and OFRS series are recommended. Refer to Section "p", "Filters" and Section "S", "Technical Information" of Vickers Catalog 400 or contact your Vickers representative for further filtration advice.

WEIGHT

Valve 9 lbs.
Subplate 3 lbs.

SERVICE INFORMATION

Refer to specific Vickers part drawing or overhaul manual for service information. A complete "Index to Industrial Products Service Information" is included in the Technical Information section of Vickers Catalog 400.

MODEL CODE

S F 4 - 140 - 20 - 002 - 10

1 2 3 4 5 6 7

1 Servo Valve

6 Nominal Coil Resistance
002 - 20 ohms

2 Type

F - Flapper nozzle

7 Design Number
Subject to change. Installation dimensions remain as shown for design numbers 10 through 19.

3 Flow Direction

4 - 4-way

4 *Flow

(at 1000 PSI)

140 - 14 GPM

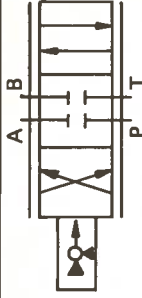
100 - 10 GPM

5 Supply Pressure

20 - 2000 PSI

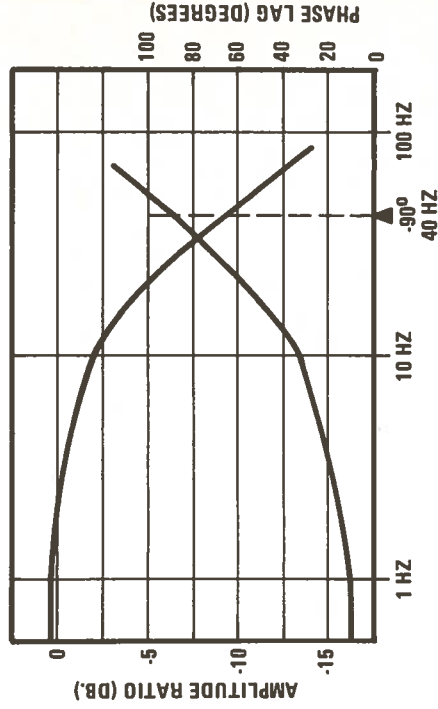
30 - 3000 PSI

* The 14 GPM value can only be obtained for a 2000 PSI supply pressure. The 10 GPM value can only be obtained for a 3000 PSI supply pressure.



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

TYPICAL DYNAMIC PERFORMANCE



VICKERS

VICKERS, INCORPORATED
A TRINOVA COMPANY
Troy, MI 48064

INSTALLATION
DATA

ELECTROHYDRAULIC
SERVO VALVES

MODEL SERIES
SF4

10 TO 14 GPM
FLOW

500 TO 3000
PSI

MANIFOLD OR
SUBPLATE
SUPPLY PRESSURE
MOUNTING

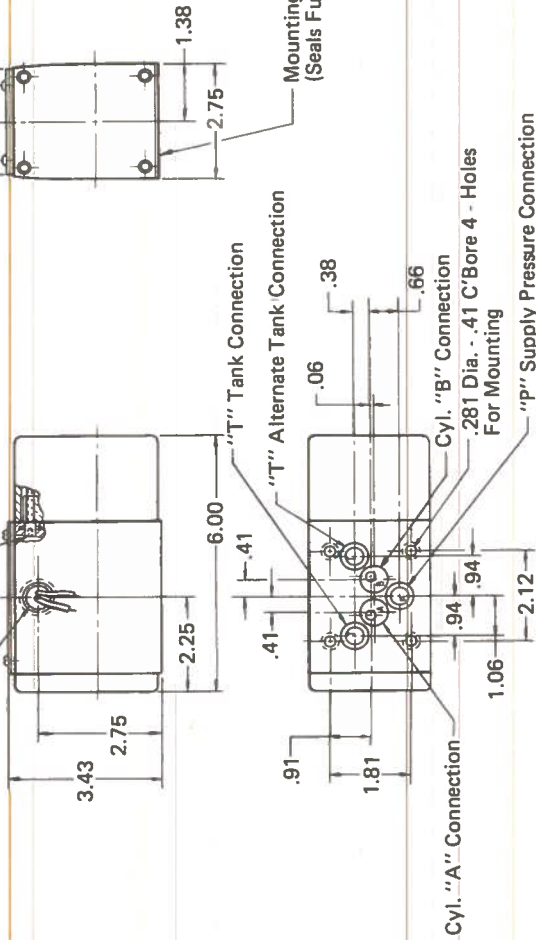
DWG. NO.
I-519600

SERVO

Revised 5-87

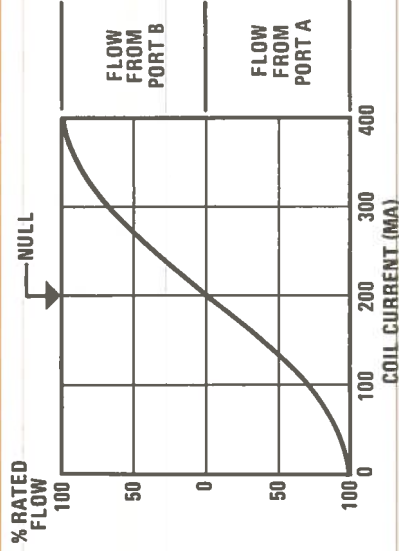
Electrical Conduit Connection
1/2 NPTF Thread (Alternate
Connection On Opposite Side)

Null Adjustment Screw (Name
Plate Must Be Removed To Make
Adjustment. Screw Has .140
Hex. Socket)

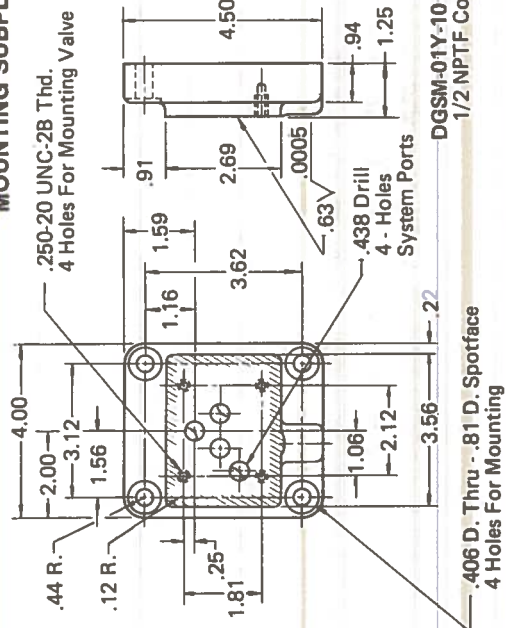


TYPICAL FLOW CURVE @ 1000 PSI Pressure Drop Across Valve

The valve will respond equally
to either polarity of coil current.



MOUNTING SUBPLATE



SUBPLATES AND BOLT KITS

Valves, subplates and mounting bolts must be ordered separately.

Example:

One (1) SF4-140-20-002-10 Valve

One (1) DGSM-01Y-10 Subplate

One (1) BKSF4-648 Bolt Kit †

Maximum Recommended

Mounting Bolt

Torque 112 lb. in.

Side connection subplates are also available with 3/8" and 1/2" NPTF threads.

When subplate is not used, a machined pad (as indicated by subplate shaded area) must be provided for mounting; pad must be flat within .0005 inch and smooth within 63 microinch.

Mounting bolts, when provided by customer, should be SAE grade 7 or better.

† See "Bolt Kit" information in Section "Q" of Vickers Catalog 400 for bolt thread size and length.

I'm a retard
RICHES,
Daddy
Sanni

SERVO MID-COURSE TEST

(50 Questions, Answer Either True or False)

TRUE FALSE

The SA4 servo valve is:

- | | | |
|-----|-----|-----------------------------------|
| A | B | |
| () | () | 1. A single stage valve. |
| () | () | 2. A sliding spool valve. |
| () | () | 3. A two-stage valve. |
| () | () | 4. An infinite positioning valve. |

The SA4 torque motor coils are connected in:

- | | | |
|-----|-----|--------------------|
| A | B | |
| () | () | 5. Parallel |
| () | () | 6. Series |
| () | () | 7. Series-parallel |
| () | () | 8. Series aiding |

The SA4 servo valve:

- | | | |
|-----|-----|--|
| A | B | |
| () | () | 9. Uses internal mechanical feedback. |
| () | () | 10. Control pressure should not exceed 1000 PSI. |
| () | () | 11. Supply pressure is not to exceed 1000 PSI. |
| () | () | 12. Has an adjustable feedback linkage. |

If two 40 ohm resistors are connected in parallel across a 12 volt source, the total current is:

- | | | |
|-----|-----|-----------------------|
| A | B | |
| () | () | 13. 0.6 Amperes. |
| () | () | 14. 1.66 Amperes. |
| () | () | 15. 600 Milliamperes. |
| () | () | 16. 300 Milliamperes. |

$V = IR$ $V = 12$ $I = 20$

$\frac{40 \times 40}{80}$

$\frac{1}{R_1} = \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R} = \frac{1}{40} + \frac{1}{40}$

$R = \frac{40}{2} = 20 = \frac{1+1}{40} = \frac{2}{40}$

The EM-D-20 amplifier can be used:

- | | | |
|-----|-----|---|
| A | B | |
| () | () | 17. In a closed loop circuit. |
| () | () | 18. To control the SM4 servo valve torque motor current. |
| () | () | 19. To control the SA4 servo valve torque motor current. |
| () | () | 20. To control the SF4 servo valve flapper-nozzle coil current. |

37
 22
 74

TRUE FALSE

The EM-D-20 amplifier:

- | A | B | |
|-----|-----|---|
| (✓) | () | 21. Can be used in either the linear or integrating mode. |
| (✓) | () | 22. Bias control is also the balance control. |
| (✓) | () | 23. Limiters control <u>minimum</u> current through the torque motor coils. |
| (✓) | () | 24. Limiters control <u>maximum</u> current through the torque motor coils. |

When balancing the EM-D-20 amplifier:

- | A | B | |
|-----|-----|---|
| (✓) | () | 25. Switches must be in the linear mode. |
| (✓) | (✓) | 26. Switches must be in the integrating mode. |
| (✓) | () | 27. The torque motor must be connected to the amplifier output. |
| () | () | 28. The input to the amplifier should be at least 0.3 volts. |
| () | (✓) | 29. Remove all signal inputs to the amplifier |

If the EM-D-20 amplifier gain is set for 1000 MA/volt and the error input voltage is 10 volts, the SA4 servo valve torque motor current is (current limiters properly adjusted):

- | A | B | |
|-----|-----|------------------------|
| (✓) | (✓) | 30. 1000 Milliamperes. |
| (✓) | () | 31. 300 Milliamperes. |
| () | (✓) | 32. 10 Amperes. |
| () | (✓) | 33. 100 Milliamperes. |

$$V = IR$$

$$.3 = I \cdot 2$$

$$I = \frac{.3}{2}$$

PROBLEM: Varying the amplifier input results in a change in the amplifier output current, but no output motion occurs, except for possible drifting of the load.

SOLUTION:

- | A | B | |
|-----|-----|---|
| () | () | 34. System is out of phase. |
| () | (✓) | 35. No power to the amplifier. |
| () | (✓) | 36. Feedback circuit is open. |
| (✓) | () | 37. Torque motor leads are incorrectly wired. |
| () | (✓) | 38. Torque motor leads not connected. |

$$V = IR$$

$$= .3 \text{ Am} \times 1$$

$$= .3$$

$$= .3$$

PROBLEM: In a velocity control system the hydraulic motor will not operate at the same maximum speed in both directions.

SOLUTION:

<u>TRUE</u>	<u>FALSE</u>	
A	B	
()	()	39. System is out of phase.
()	()	40. One of the torque motor coils is open.
()	()	41. Servo valve is out of balance.
()	()	42. Amplifier is out of balance.

PROBLEM: In a positional system the cylinder cannot be controlled, but goes to either extreme position.

SOLUTION:

A	B	
()	()	43. Balance the amplifier.
()	()	44. Reverse the feedback excitation.
()	()	45. Reverse the torque motor leads.
()	()	46. Reverse the command excitation.

PROBLEM: In a positional system the cylinder positions (comes to a stop), but not as close as required:

SOLUTION:

A	B	
()	()	47. The amplifier gain is set too low.
()	()	48. The dither may be too low.
()	()	49. The system is out of phase.
()	()	50. The amplifier gain is set too high.

BASIC ELECTRICITY

SERIES CIRCUIT RULES

1. The total resistance in series circuit is the sum of the individual resistances.

$$R \text{ Total} = R_1 + R_2 + R_3 + \dots \text{etc.}$$

2. The current in a series circuit is the same through all components.
3. The sum of the individual voltage drops will add up to the source voltage.

PARALLEL CIRCUIT RULES

1. The total resistance of a parallel circuit can be found by the following formulae:

(a) For only two parallel resistors:

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

(b) For more than two parallel resistors:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \text{etc.}$$

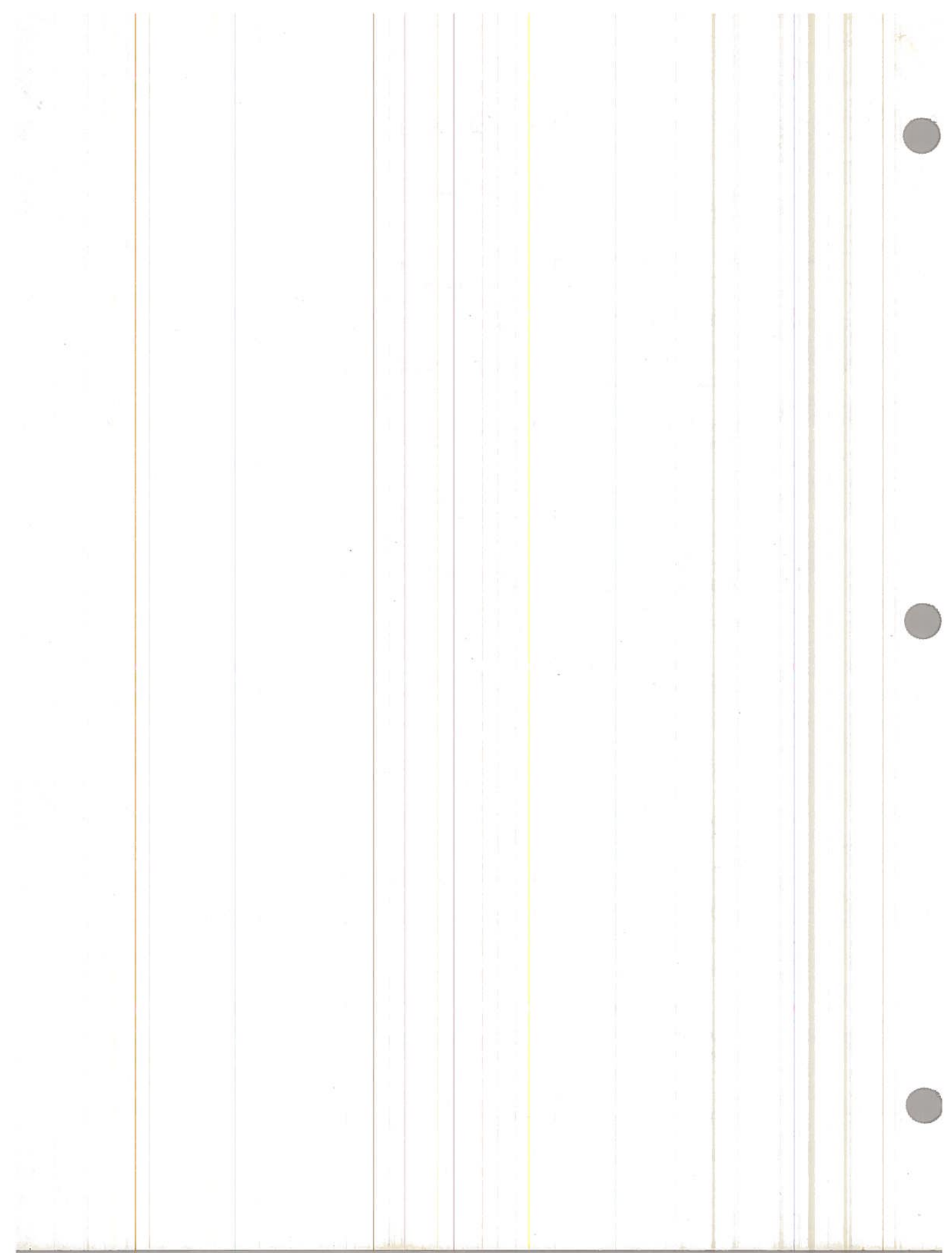
(c) For identical parallel resistors:

Divide the value of one resistor by the total number of identical resistors.

For example: Ten (10) 500 OHM resistors in parallel. Divide 500 by 10, answer: 50 Ohms.

2. The voltage drop across each branch (resistance) is the same.
3. The total current in a parallel circuit is the sum of the currents in the individual branches.

$$I_T = I_1 + I_2 + I_3 + \dots \text{etc.}$$

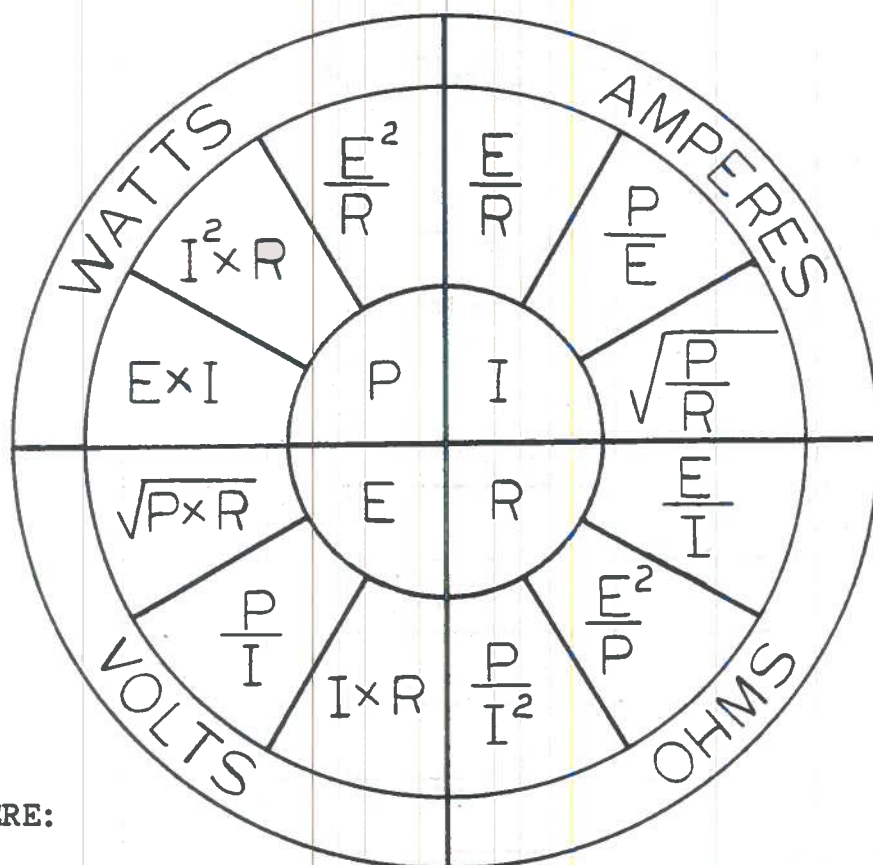


RESISTOR COLOR CODE

<u>COLOR</u>	<u>1ST DIGIT</u> A	<u>2ND DIGIT</u> B	<u>MULTIPLIER</u> C	<u>TOLERANCE</u> D
BLACK	0	0	1	
BROWN	1	1	10	
RED	2	2	100	
ORANGE	3	3	1,000	
YELLOW	4	4	10,000	
GREEN	5	5	100,000	
BLUE	6	6	1,000,000	
VIOLET	7	7	10,000,000	
GRAY	8	8	100,000,000	
WHITE	9	9		
GOLD				± 5%
SILVER				± 10%
NO COLOR				± 20%



OHM'S LAW COMBINED WITH JOULES LAW



WHERE:

I=Current in Amperes

R=Resistance in Ohms

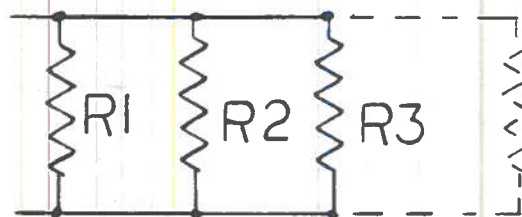
E=Potential in Volts

P=Power in Watts

RESISTANCE IN SERIES:



RESISTANCE IN PARALLEL:



FOR TWO RESISTORS IN PARALLEL:

$$R = \frac{R_1 \times R_2}{R_1 + R_2}$$

ELECTRICAL CIRCUITS

Terms

<u>TERM</u>	<u>SYMBOL</u>	<u>UNIT</u>	<u>RELATIONSHIPS</u>
Voltage or Potential	V or E	Volts	
Charge	q	Coulombs	
Current	I	Amperes	$i = \frac{dq}{dt}$
Power	W	Watts	$W = EI$
Resistance	R	Ohms	$R = \frac{E}{I}$ (Ohms law)
Inductance	L	Henries	$v = L \frac{di}{dt}$
Capacitance	C	Farads	$c = \frac{q}{V}$
Time Constant	Tc	Seconds	$T_c = RC$ $T_c = \frac{L}{R}$ (from $v = V e^{-n}$, $n = \frac{R}{L}t$ or $\frac{1}{RC}t$ when $n = 1$, $\frac{L}{RC} = 63\%$)
Voltage (ac)	V	Volts	$v = V_{peak} \sin wt$ $V_{rms} = 0.707 V_{peak}$
Current (ac)	I	Amperes	$i = I_{peak} \sin (wt + \theta)$ $I_{rms} = 0.707 I_{peak}$
Impedance	Z	Ohms	$Z = \frac{V}{I}$ $Z^2 = R^2 + X^2$
Inductive Reactance	X_L	Ohms	$X_L = wL = 2\pi fL$

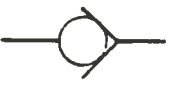
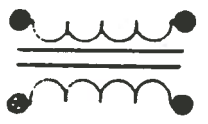
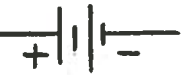
<u>TERM</u>	<u>SYMBOL</u>	<u>UNIT</u>	<u>RELATIONSHIPS</u>
Capacitive Reactance	X_c	Ohms	$X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C}$
Power	W	Watts	$W = VI \cos \theta$

Common units other than these above -

Current in milliamperes (1×10^{-3} amps)

Capacity in microfarads (1×10^{-6} farads)

ELECTRICAL CIRCUITS SYMBOLS

RESISTOR - OHMS		
RESISTOR VARIABLE		
POTENTIOMETER		
INDUCTOR - HENRIES		
CAPACITOR - FARADS		
DIODE		
ZENER DIODE		
TRANSFORMER		
SWITCH		
PUSH BUTTON		
RELAY		
BATTERY		
GENERATOR		
TACH GENERATOR		



ELECTRICAL LAB WORK SHEET

OBJECTIVE:

To familiarize the student with the proper methods used in making resistance, voltage, and current measurements.

EQUIPMENT:

1. Combination voltmeter, ohmmeter, and current meter.
2. Breadboard with fanstock clips.
3. Hook-up wire.
4. Resistors
(7) fixed resistors
5. Potentiometer
6. Resistor color code sheet.

PHASE I - RESISTANCE MEASUREMENTS

PROCEDURE: (Set VOM to Measure Resistance)

1. A.

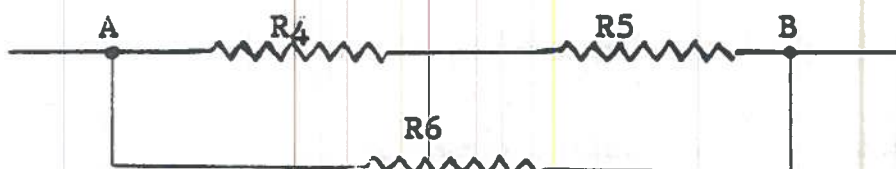
<u>Measured Resistance</u>	<u>Resistance as Indicated</u>
<u>List in Ascending Values</u>	<u>by Color Coding</u>
R1 <u>470</u> ohms	R1 _____ ohms
R2 <u>1000</u> ohms	R2 _____ ohms
R3 <u>20 K</u> ohms	R3 _____ ohms
R4 <u>10 K</u> ohms	R4 _____ ohms
R5 <u>4700</u> ohms	R5 _____ ohms
R6 <u>47 K</u> ohms	R6 _____ ohms
R7 <u>5100</u> ohms	R7 _____ ohms
- B. Is the measured resistance within the tolerance indicated on the resistors? 5%.
- C. Connect R4 and R5 in series.

-2-

D. Measure total resistance 15.45 ohms.

2. Select R6.

A. Connect R6 in parallel with R4 and R5.



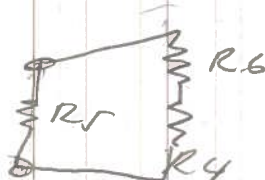
B. Measure the resistance from point (A) to point (B) 8.74 ohms.

C. Measure the resistance of R5 7.36 ohms.

(a) Is there any difference from the reading obtained for R5 in 1.A. Y?

(b) Explain: parallel circuit

(c) Draw equivalent circuit.

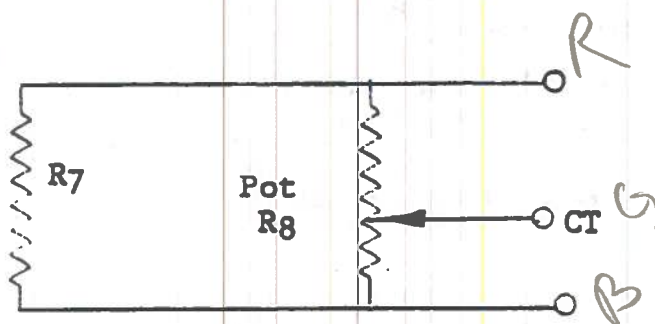


3. Select R8.

A. Measure resistance of R8 25.30 ohms.

B. Turn shaft to read one half the above value from center connection to one side 12.50 ohms.

C. Place R7 in parallel with the pot R8.



-3-

D. Measure resistance-center tap to one side 10.36 ohms.

(a) Is there a difference from 3B ✓ ?

(b) Explain: 11 circuit

(c) Draw equivalent circuit.

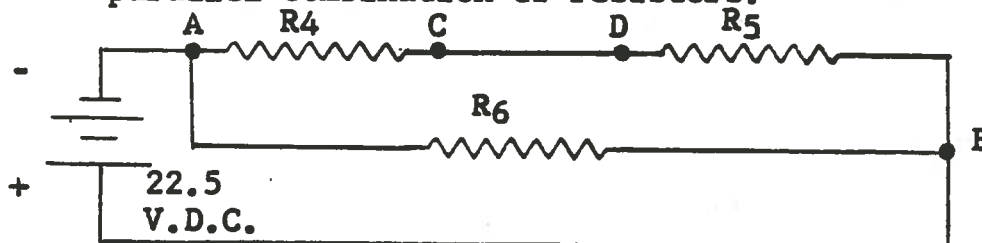


PHASE II - VOLTAGE MEASUREMENTS

PROCEDURE: (Set VOM to Measure D.C. Voltage)

NOTE: Voltage range selector should be set on a range exceeding the expected voltage to be measured.

1. Connect a 22.5 V.D.C. battery to the series parallel combination of resistors.



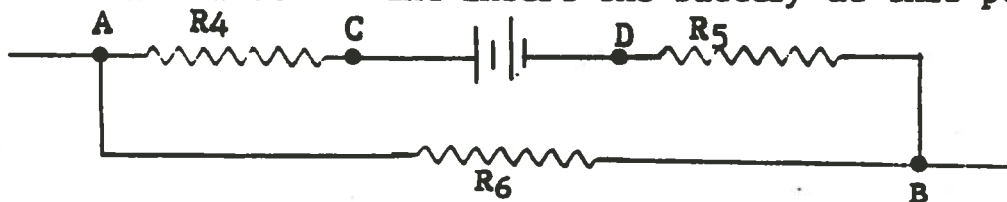
CAUTION: OBSERVE POLARITY - HIGH RANGE

A. Measure the voltage from point (a) to point (b) 22.93 volts.

B. Voltage across R4 7.60 volts.

C. Voltage across R5 15.31 volts.

2. Remove wire C-D and insert the battery at this point.



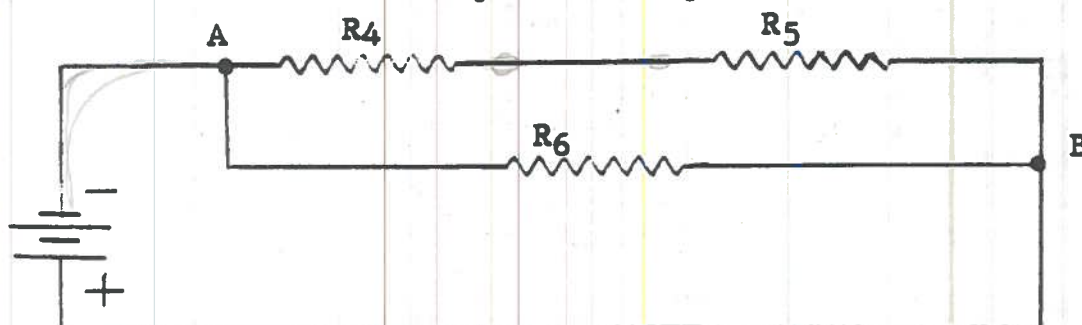
-4-

- A. Measure the voltage from point (A) to point (B) 16.39 volts.
- B. Voltage across R_4 3.32 volts.
- C. Voltage across R_5 6.70 volts.

PHASE III - CURRENT MEASUREMENT

PROCEDURE:

Set meter to read current. NOTE: Value greater than anticipated to be read in the circuit (Hi Range) and with the circuit connected as in the previous experiment.



1. Connect meter to read current thru.

I R_4 1.476 amps. .90
 I R_5 1.4753 amps.
 I R_6 1.1363 amps.
 I_t 2.625 amps.

2. Connect circuit as shown below. Measure and record the following:

I R_2 and R_3 3.79 amps.

Vary the Pot. does I R_2 and R_3 vary? no

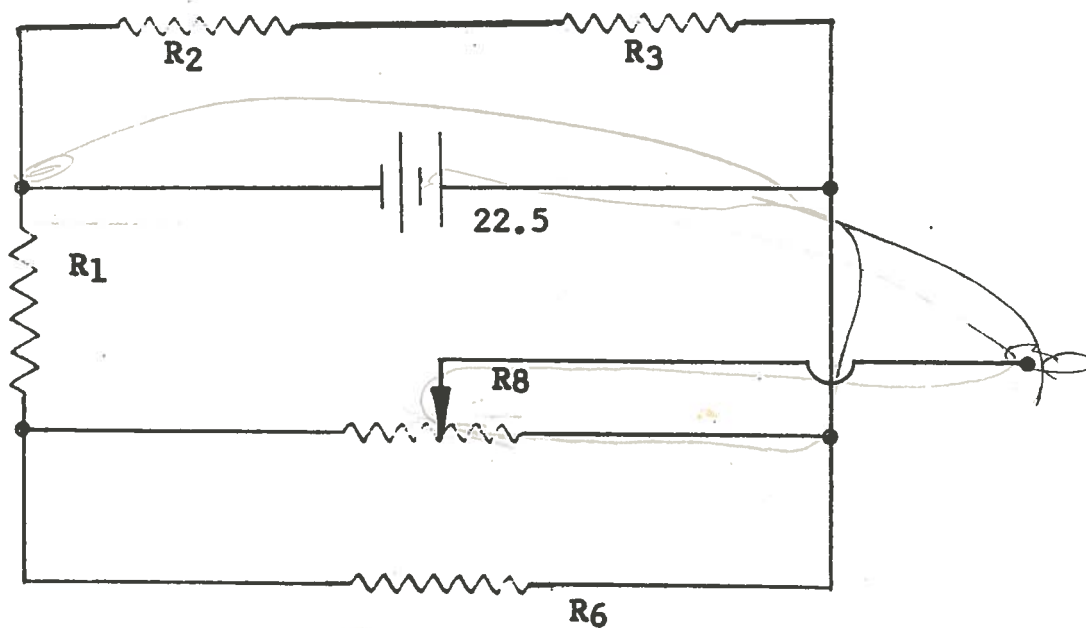
Measure and record:

I R_8 .86 amps.

Vary the Pot. does I R_8 vary? no

-5-

Measure total current 5.73 amps.



Voltmeter $\rightarrow$ 
 Ammeter $\rightarrow$ 

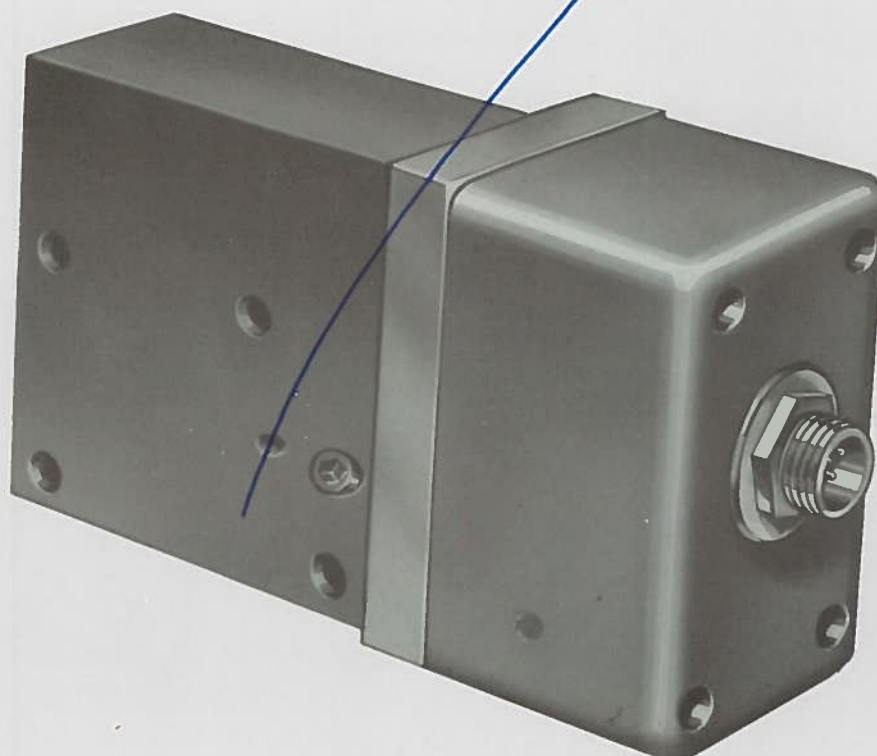


Overhaul Manual

2 - STAGE
SERVO VALVES

SA4-03-**-***-1*

SA4-06-**-***-1*



Overhead Manual

UNITED STATES
NATIONAL ARCHIVES

STATE - 9
SERIAL - 23



1000

1000

1000

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OPERATING CHARACTERISTICS

TYPE.....Electro-hydraulic two-stage servo valve
 OPERATING FLUID.....Clean hydraulic fluid
 FILTRATION.....10 Micron

TYPE MOUNTING.....Sub-plate, manifold
 MOUNTING POSITION.....Optional

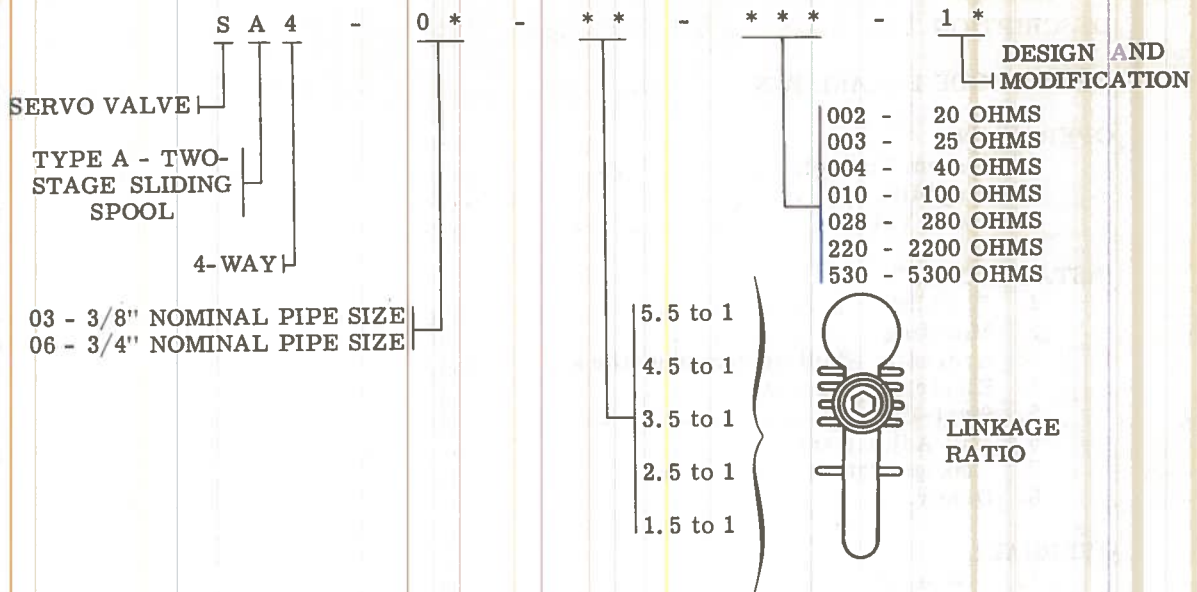
COIL RESISTANCE- OHMS PER COIL (NOMINAL)	INPUT DIFFERENTIAL CURRENT-ma	DEADBAND	MAXIMUM NULL SHIFT	HYSTERESIS	POWER REQUIRED - watts (Approx)
20	400	.2% OPEN LOOP WITH DITHER	.03%/°F	Less than Two Percent	3
25	360				
40	300				
100	175				
280	100				
2200	40				
5300	25				

DESCRIPTION

This manual contains operation, service and over-haul information for the SA4 Series Servo Valves. Units are identified on the nameplate. Figure 1 schematically illustrates the construction in cross-section.

Servo valves are comprised of a rectangular body containing four moving parts: a precision fitted pilot spool and sleeve, main spool and mechanical feedback linkage. Each valve uses a permanent magnet torque motor for pilot spool actuation.

MODEL CODE BREAKDOWN



OPERATION

SYSTEM CONTROL. In electro-hydraulic servo valve systems, the control or command and feedback elements are electrical. As indicated in Figure 2, the command signal (which may be a tape control, punched card, dials, push button, etc.) dictates the operation of the servo valve to provide control of work as to sequence, direction, velocity, position, acceleration, and so on, or a combination of these. Feedback transducers (devices such as potentiometers, synchros, tachometers, accelerometers, etc.) can be used to measure results of the actual load motion in a closed loop hydraulic circuit. The electrical feedback signal can then be compared electrically with the command signal. If a difference between the feedback and command exists, the error current which results makes a correction to bring the system toward the desired command input.

AMPLIFIER. The input command signal and the feedback signal of a servo system normally are both of very low power. They must be amplified, or increased in strength, to a level which is usable by the torque motor of the servo valve. This is done by the servo amplifier.

SERVO VALVE. The servo valve provides a flow proportional to the electrical current applied to it. The direction of flow is dictated by the polarity of the DC signal. This electrical signal can be the amplified command signal or the error signal as described above.

The SA4 Series servo valves consist of two stages --the pilot stage and the main stage. As shown in Figure 1, the upper spool and sleeve comprise the pilot stage which controls the movements of the lower main stage spool. Hydraulic fluid is metered and directed to and from the work by the main stage. This is accomplished in the following manner:

(See Figure 1.) When the electrical signal from the amplifier directs the torque motor to move the pilot spool, hydraulic fluid is metered to or from the 2A end of the main spool. Control pressure is always

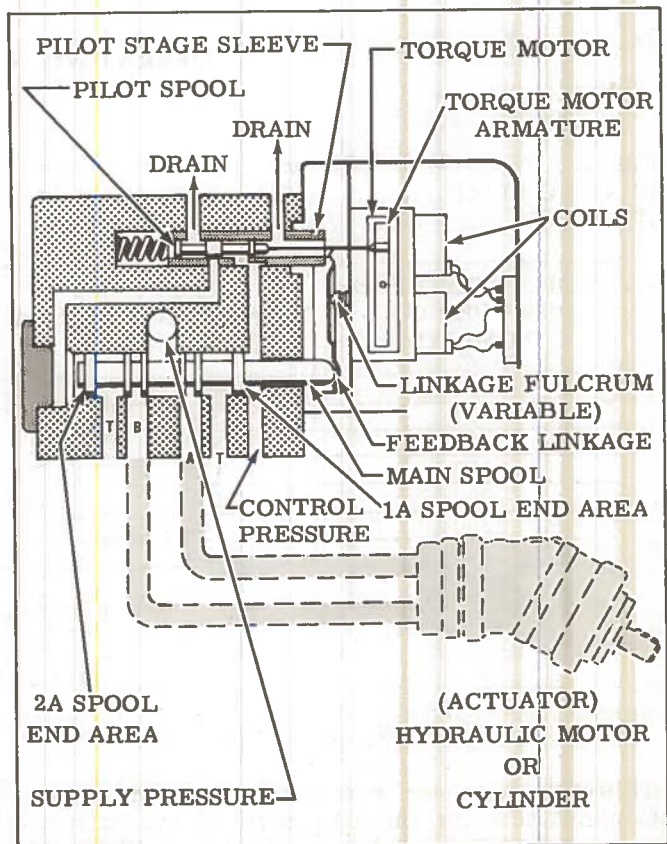


Figure 1. Schematic Sketch of Servo Valve

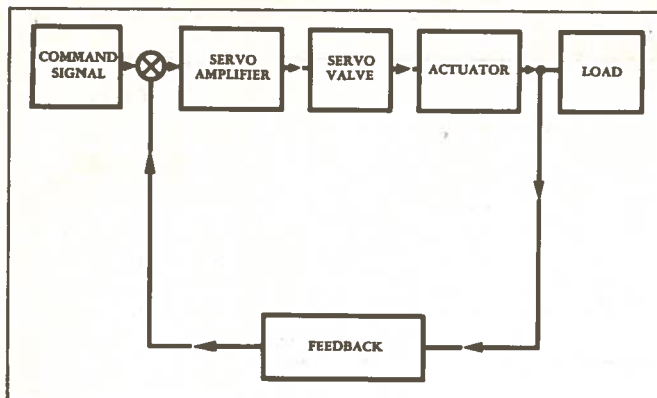


Figure 2. Servo Valve System Block Diagram

present against the 1A end area of the main spool. Since the 2A end area of the main spool is twice that of the effective area on the 1A end, the same pressure on both ends (or greater area of force on the 2A end) will cause the main spool to shift right. As the pilot moves to the right, fluid is permitted to drain back to tank from the 2A end and relieve pressure. When pressure on the 2A end of the main spool reduces to less than one-half the control pressure of the 1A end,

the pressure at the 1A end moves the spool to the left. Fixed position of the main spool is achieved when the pressure in the 2A end is one-half the control pressure at the 1A end. Movement of the main spool is transmitted through the mechanical linkage to the pilot valve sleeve. The main spool continues to move until the pilot valve sleeve moves far enough to close off the flow of control fluid.

The main spool directs the flow to either pressure port "A" or "B" of the valve. Relationship of the spool to its stationary sleeve determines the amount of fluid metered to and from the motor or cylinder.

Independent control pressure can be supplied from a separate source such as a separate pump or from the supply pressure source using pressure reducing valves and accumulators. A separate source for the control pressure is preferred because:

- 1) It provides flexibility for trimming system to a fine point by careful adjustment of one pressure with another.
- 2) It permits separate filtration of control hydraulic fluid.
- 3) It is less power wasting.
- 4) The maximum control pressure preferred is 1000 PSI while the supply pressure may be as high as 3000 PSI.
- 5) It eliminates interaction of load fluctuation on pilot spool response in critical systems.

INSTALLATION

Installation Drawing 501500 shows correct valve dimensions, port location, sub-plate mountings and other data. Vickers Machinery Division application engineering personnel should be consulted to determine correct valve use and other assistance. Because of the extreme precision required of servo valve operation, extra precautions must be taken with the application of the valve to the circuit.

All piping should be thoroughly cleaned and pickled. Reservoirs should be carefully cleaned and flushed prior to addition of hydraulic fluid.

Full flow filters (10 micron) should be installed in both supply lines and control pressure lines. If desired, parallel filters can be installed with shut-off valves arranged so filters can be changed without interrupting system operation.

HYDRAULIC FLUID SHOULD BE FILTERED TO 10 MICRONS WHILE FILLING RESERVOIR.

FLUSHING.

Complete flushing of the hydraulic system will save considerable time in start-up and down time of the servo system.

Before installing servo valve, flush the hydraulic system with clean fluid. A flushing plate (see Figure 3) can be purchased from any Vickers branch. It should be installed on the work face or mounted by means of a sub-plate to permit free return of hydraulic fluid from pressure to tank. Flush the system from one to two hours. Then, replace the full flow filter cartridges and continue to flush. This procedure should be continued until filter elements and the bottom of the filter housing are free from contamination. After the system is clean, install the servo valve.

MOUNTING. Hydraulic connections between a servo valve and the actuator it controls can be made by a sub-plate or manifold. Or the servo may be attached directly to a prepared, flat, ported face of the work unit. The sub-plate (SVGM2-03-10 or SVGM2-06-10) permits pipe connections with the work unit. Manifolds (SVGM1-*-03-10, SVGM5-*-06-11 and SVGM6-*-06-10) allow direct manifolding of the SA4 series valves to any MF-2003-A thru MF-2020-A size hydraulic motor. Manifolds may be obtained with three variations: (1) with cross line relief valves and variable orifice (2) with cross line relief valves only, (3) with variable orifice only. In all applications, the servo valve is attached by four mounting screws which should be tightened to the torque values specified in the overhaul section, page 5.

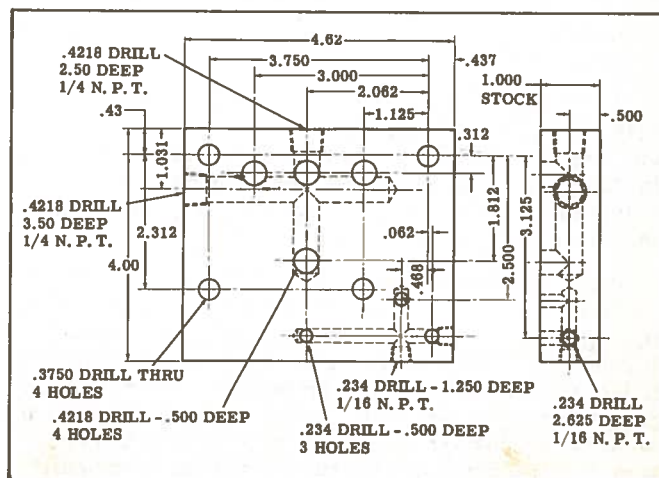


Figure 3. 938714 Flushing Plate

The mounting face of the servo valve has ten ports, each containing an "O" ring. When the servo valve is mounted the "O" rings are compressed, providing a leakproof installation.

HYDRAULIC FLUID RECOMMENDATIONS. Hydraulic fluids are required to perform the dual functions of lubrication and transmission of power. Thus, oil should be selected with care with the assistance of a reputable oil supplier. If fire resistant fluid is required, Vickers Application Engineering personnel must be consulted.

ELECTRICAL CONNECTION. It is desirable to install milliammeters in series with the torque motor connections as shown in Figure 4. This will prove valuable for isolating electrical and hydraulic problems occurring during system trim and in trouble shooting electrical problems.

Electrical connections between the system and the torque motor should be checked to insure that they are in accordance with Figure 4.

When current through terminals "A" and "B" (Figure 4) is greater than current through terminals "C" and "D," flow from Port "B" (Figure 1) to the fluid motor or cylinder increases.

When current through terminals "A" and "B" is less than current through terminals "C" and "D," flow from Port "A" (Figure 4) increases.

When the electrical system is turned on, current to the two coils should be balanced (1/2 input differential in each coil).

START-UP. After electrical connection is made, the hydraulic system can be started (with feedback devices disconnected). With balanced current in the coils, the actuator controlled by the servo valve should not move. If movement of the actuator in either direction is excessive at this stage, and the current to the torque motor coils is still balanced, the spool of the servo valve is probably not centered.

NULL ADJUSTMENT. Null is accomplished by loosening set screw (32), then turning adjusting screw (33) clockwise to increase the flow out of Port A; counterclockwise to increase the flow out of Port B.

When sufficient adjustment cannot be made to properly center the valve, remove the torque motor cover and adjust the pilot spool with a 3/64 Allen wrench. In doing this, it should be remembered the torque motor is immersed in oil which will be released when the cover is loosened.

If the actuator (i. e., motor or cylinder) continues to move, after the spool is properly centered, check the electrical signal shown in the milliammeters. If the current to the servo valve also varies or is unbalanced, the difficulty is probably in the electrical programming circuit. But if the milliammeters are showing a constant current without feedback connection and the actuator is still fluctuating erratically, the trouble is probably in the servo valve or else-

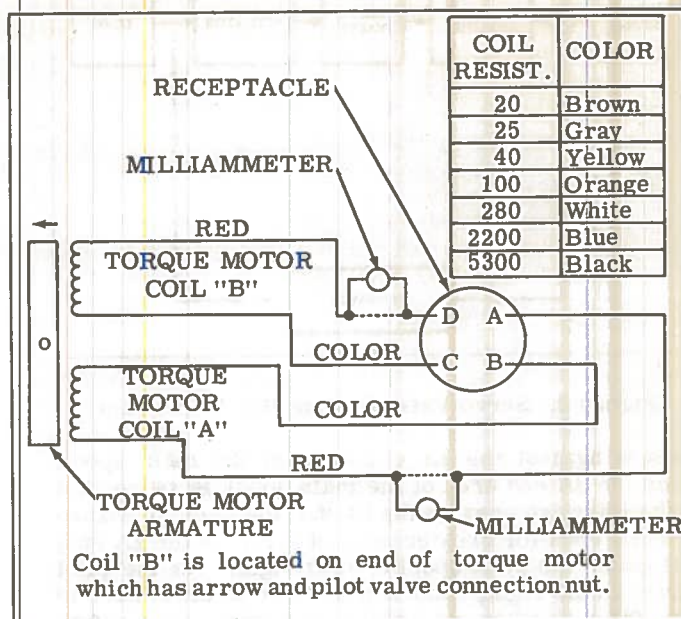


Figure 4. Wiring Diagram - Schematic View.

where in the hydraulic system. If difficulty still exists after preliminary checking, the trouble shooting table on page 6 should help locate it.

LINKAGE RATIO. (See Table I.) Linkage ratio is the relationship of pilot spool movement to main spool movement of the valve. This ratio is stamped into the nameplate of each unit. Linkage ratio is set at the factory based on information furnished with customers orders. Required flow, load pressure, available supply and control pressure should be specified. If this information is not furnished with the order, valves will be shipped with a 3 1/2 to 1 ratio. Adjustment, if necessary, must then be made in the field.

To adjust linkage ratio, (1) remove cover and torque motor, (2) loosen fulcrum screw with a 5/32 Allen wrench, (3) slide the fulcrum screw up or down in its slot. Ratio figures are stamped in the adaptor plate for reference in screw movement. If ratio is readjusted, have nameplate restamped.

DITHER. The purpose of dither is to eliminate stiction and to increase the dirt tolerance within the valve. To accomplish this, it is necessary to keep the pilot spool moving within the deadband of the valve.

In every application, dither of 60-400 cycles must be applied to the pilot stage of the servo valve. Readily available 60-cycle current usually answers the dither requirement in the easiest and least expensive way.

Dither should be established as follows: increase the amplitude of the dither until it can be felt at the output of the actuator. Then, slowly back down on the adjustment until no vibration can be felt on the actuator output.

OVERHAUL

DISASSEMBLY.

CAUTION

Before removing a unit or a part of a unit from a hydraulic circuit, be certain the unit concerned is not subject to hydraulic pressure or to an electrical power source.

Complete disassembly of the servo valve should be undertaken only at periodic intervals as recommended by the manufacturer or as determined by the application and operating conditions. Otherwise, a servo valve should not be disassembled further than necessary to correct a malfunction. Follow the sequence of index numbers shown in Figure 6 for disassembly.

When disassembling a servo valve, special attention should be given to identification of parts for proper reassembly. This is especially important for returning the valve spools, sleeves, and other related parts in correct relationship to each other and to the block. The torque motor is a wet type so that removal of the cover results in the release of hydraulic fluid. Slightly oversize holes in the torque motor base permit proper readjustment of the torque motor as it is secured to the servo body. Attention also must be given to mating port holes in mountings and gaskets on the bottom face of the valve block.

CAUTION

Never use an air hose on or near a hydraulic device because of water and dirt in the air stream.

Check the valve spools and block bores for roughness or scratches. Slight scratches and abrasions can be removed with crocus cloth or light lapping. Do not round off sharp edges of valve spool lands. Coat the spools with hydraulic fluid and test in the block bore for freedom of movement.

A malfunction of the torque motor can be checked by energizing with proper current and measuring armature deflection. Maximum current should give

.020 movement of the armature in each direction. If this deflection does not occur, a continuity check of the coils should be made with a volt-ohmmeter. If the torque motor or any parts on the pilot spool linkage appear to be damaged, they can be replaced with new parts.

REASSEMBLY.

Before reassembly of the servo valve, coat all parts with hydraulic fluid and replace all seals and gasket.

For proper reassembly, an alignment tool (Figure 5) must be used. This tool can be procured from any Vickers branch. It is the only special tool required.

SPOOL CENTERING. Assemble sleeve sub-assembly (36) flush with body (37) at the adapter end (13) then, assemble torque motor so hole which normally receives the threaded end of the pilot spool is aligned with the threaded end of the alignment tool.

NOTE

Alignment tool must be clean before using.

Tighten down the torque motor and remove the alignment tool. Assemble the pilot spool to the torque motor. Install the valve on the system and adjust the pilot spool for center at the torque motor armature nut with a 3/64 Allen wrench. Replace the cover and trim if necessary as outlined in null adjustment paragraph, page 4. Otherwise, reassembly is in reverse of disassembly. Follow index numbers of Figure 6 in reverse order.

MOUNTING BOLT TORQUE

MODEL NUMBER	TORQUE lb. in.
SA4 - 03 - ** - *** - 10, 11, 12	35 - 40
SA4 - 03 - ** - *** - 13, 14, 15	80 - 85
SA4 - 06 - ** - *** - 10, 11	35 - 40
SA4 - 06 - ** - *** - 12, 13	80 - 85

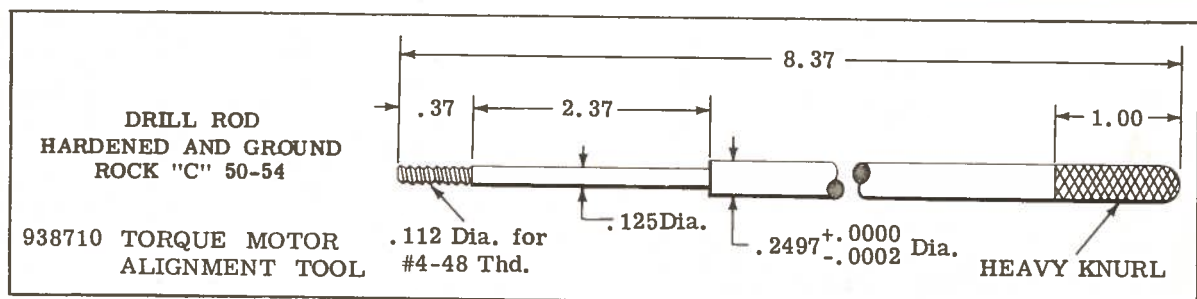


Figure 5. Alignment Tool

TROUBLE SHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
No Load Movement	Insufficient control pressure or supply pressure.	Check the control pressure or supply pressure -- the gage installation should be close to the servo valve.
	Improper or poor electrical connections.	With the amplifier or signal source turned off, check continuity with an ohmmeter for: cold solder joints on the electrical connectors, broken leads, and for improper pin wiring.
	Flow ports blocked.	Check for proper manifolding ("O" rings) and for obstructions or improper piping of the hydraulic lines.
	Servo valve mounting bolts too tight.	Loosen the four servo valve mounting bolts and adjust to the values specified in overhaul section, page 5.
	Amplifier or signal source inoperative.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line "A" and the other in series with line "D," and check for the proper differential currents.
	Torque motor inoperative.	With the amplifier or signal source turned off, check the torque motor coils for either an open or shorted condition by placing an ohmmeter across pins "A" and "B" of the electrical connector for one coil and across pins "C" and "D" for the other.
Load Movement In Only One Direction	Pilot spool not centered.	Recenter pilot spool. Refer to Page 4.
	One torque motor coil inoperative.	With the amplifier or signal source turned off, check the torque motor coils for either an open or shorted condition by placing an ohmmeter across pins "A" and "B" of the electrical connector for one coil and across pins "C" and "D" for the other.
	Improper or poor electrical conditions.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line "A" and the other in series with line "D" and check for improper differential currents.
	Insufficient control pressure.	Check the control pressure--the gage installation should be close to the servo valve.
	Flow port blocked.	Check for proper manifolding ("O" rings) and for obstructions or improper piping of the hydraulic lines.
Movement of load in both directions, but maximum load movement obtainable in only one direction	Pilot spool not centered.	Recenter pilot spool. Refer to Page 4.
	Amplifier or signal source null shift.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line "A" and the other in series with line "D" and check for the proper differential currents. Refer to operating characteristics.
	Main sleeve too far out of adjustment.	Refer to spool centering adjustment page 5. Then null adjustment page 4.
Erratic Load Movement	Contamination.	Install the proper filter required. Clean the system components, and thoroughly flush the system.

TROUBLE	PROBABLE CAUSE	REMEDY
Erratic Load Movement (Continued)	Erratic input signal from amplifier or signal source.	Check the amplifier or signal source for stability and check the input signal to the torque motor for freedom from hash and pick-up. Shield the input cables wherever required.
	Servo valve mounting bolts too tight.	Loosen the four servo valve mounting bolts and tighten to the values specified in overhaul section, page 5.
Uncontrolled Load Movement	Insufficient control pressure.	Check the control pressure--the gage installation should be close to the servo valve.
	Amplifier or signal source defective or inoperative.	Install milliammeters between the torque motor and amplifier or signal source, one in series with line "A" and the other in series with line "D" and check for improper differential currents. Refer to differential currents as specified in operating characteristics for full deflection of specific torque motor.
	Torque motor defective or inoperative.	With the amplifier or signal source turned off, check the torque motor coils for either an open or shorted condition by placing an ohmmeter across pins "A" and "B" of the electrical connector for one coil and across pins "C" and "D" for the other. Check all four pins to ground.
	Servo valve mounting bolts too tight.	Loosen the four servo valve mounting bolts and tighten to the values specified in overhaul section, page 5.
Load Movement in the Wrong, or Opposite Direction	Torque motor wiring incorrect.	Reverse input polarity or switch leads "A" and "D" to the torque motor electrical connector.
	Amplifier, signal source current polarity, or wiring incorrect.	Reverse input polarity or switch leads "A" and "D" to the torque motor electrical connector.
External Leakage out of Cover Around Cover Bolts	Copper gasket defective.	Replace gasket.
External Leakage out of Cover Around Plug Electrical Connector	Defective "O" ring seal.	Replace "O" ring.
	Connector pin not in locator hole.	Relocate plug in mounting hole.
External Leakage Between Cover and Adapter Plate	Defective adapter "O" ring seal.	Replace "O" ring.
External Leakage Between Valve Body and Adapter Plate	Defective gasket in bath-tub shape opening.	Replace gasket
External Leakage From End Cap of Main Spool Bore	Defective "O" ring.	Replace "O" ring.
External Leakage Between Valve Body and Sub-Plate	Blown "O" ring.	Replace "O" ring.
External Leakage From Bore Plugs (Pipe Plugs)	Plugs not tight or imperfect threads.	Replace plugs.
Extreme External Leakage From Cover	Drain line restricted.	Check line to insure free drain to tank.

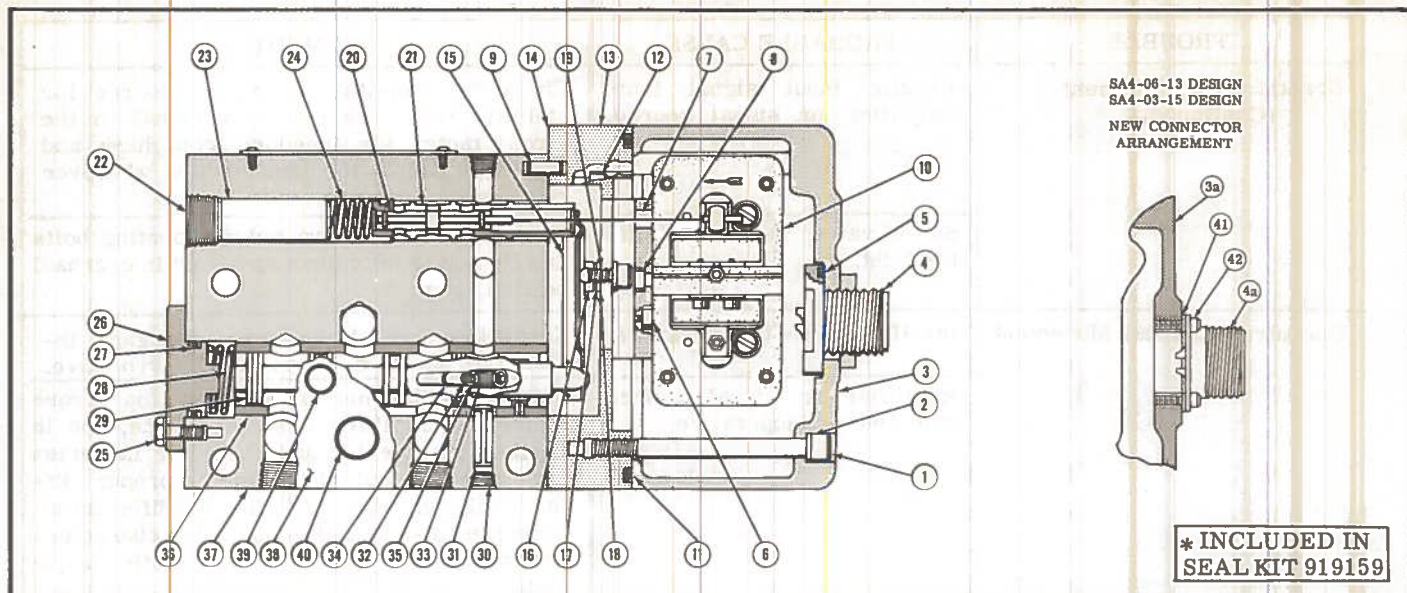
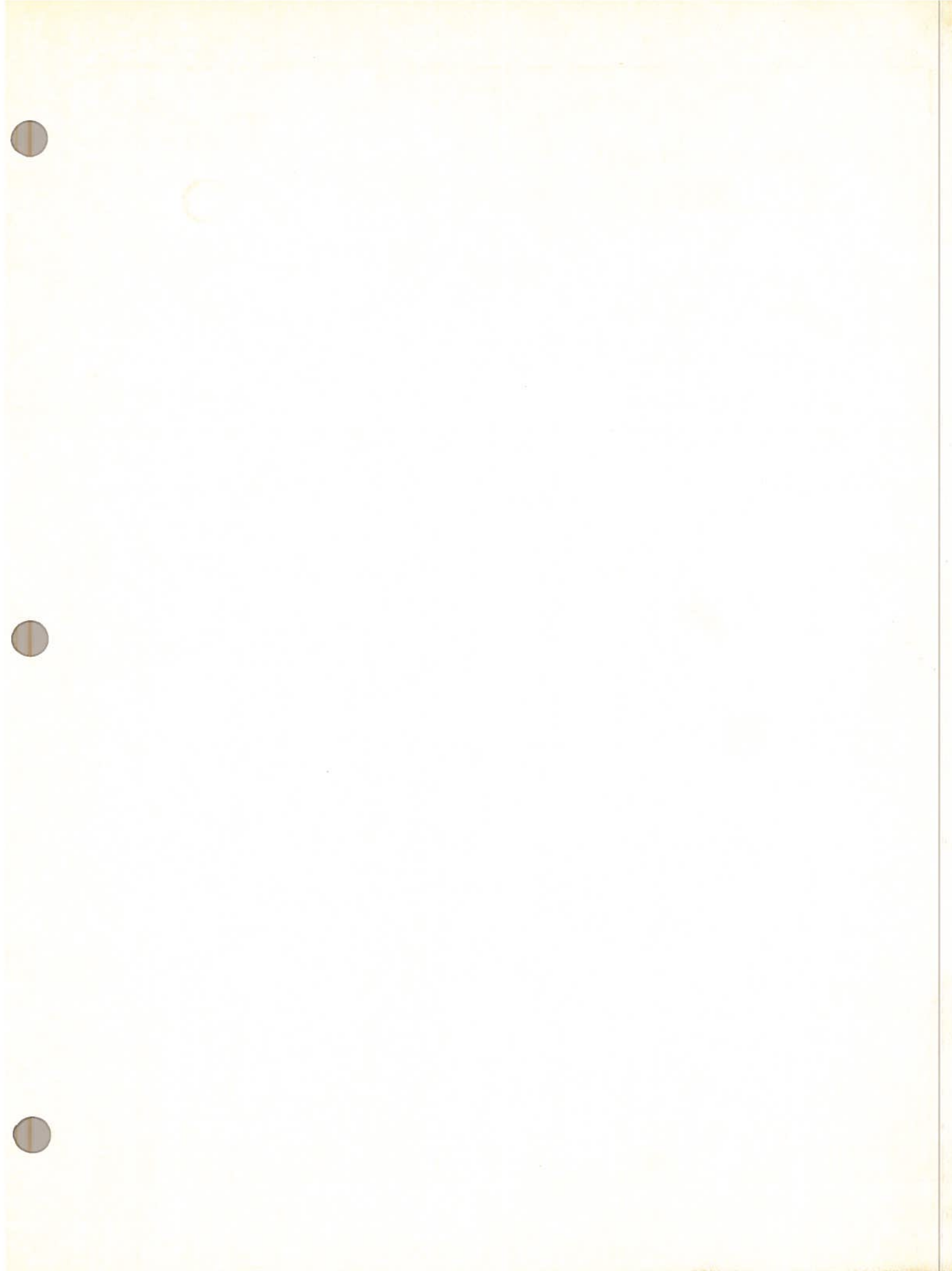


Figure 6. Servo Valve Assembly - Cross Sectional View

CODE	PART NO.	NAME	SA4-03-**-***-10	SA4-03-**-***-11	SA4-03-**-***-13	SA4-03-**-***-14	SA4-03-**-***-15	SA4-06-**-***-10	SA4-06-**-***-11	SA4-06-**-***-12	SA4-06-**-***-13
1	10935	SCREW	4	4	4	4	4	4	4	4	4
* 2	48170	GASKET	4	4	4	4	4	4	4	4	4
3	223051	COVER	1	1	1	1	1	1	1	1	1
3a	424687	COVER					1				1
4	177917	RECEPTACLE	1	1	1	1		1	1	1	1
4a	243233	RECEPTACLE					1				1
* 5	230666	"O" RING	1	1	1	1		1	1	1	1
6	125792	SCREW	4	4	4	4	4	4	4	4	4
7	223049	MTNG. PLATE	1	1	1	1	1	1	1	1	1
8	126017	SCREW	2	2	2	2	2	2	2	2	2
9	226816	ROLL PIN	1	1	1	1	1	1	1	1	1
10		TORQUE MTR.									
	319237	20 OHM	1	1	1	1	1	1	1	1	1
	290994	25 OHM	1	1	1	1	1	1	1	1	1
	212619	40 OHM	1	1	1	1	1	1	1	1	1
	285329	100 OHM	1	1	1	1	1	1	1	1	1
	207691	280 OHM	1	1	1	1	1	1	1	1	1
	207692	2200 OHM	1	1	1	1	1	1	1	1	1
	211458	5300 OHM	1	1	1	1	1	1	1	1	1
*11	154099	"O" RING	1	1	1	1	1	1	1	1	1
12	8077	SCREW	6	6	6	6	6	6	6	6	6
13	223052	ADAPT. PLATE	1	1	1	1	1	1	1	1	1
*14	224685	GASKET	1	1	1	1	1	1	1	1	1
15	936505	BEAM S. A.	1	1	1	1	1	1	1	1	1
16	223926	NUT	1	1	1	1	1	1	1	1	1
17	6455	LOCKWASHER	1	1	1	1	1	1	1	1	1
18	73826	WASHER	2	2	2	2	2	2	2	2	2
19	223662	SCREW	1	1	1	1	1	1	1	1	1
20	223047	PIL. SPL. S. A.	1	1	1	1	1	1	1	1	1
21	214319	PIL. SPL. SLV.	1	1	1	1	1	1	1	1	1

CODE	PART NO.	NAME	SA4-03-**-***-10	SA4-03-**-***-11	SA4-03-**-***-13	SA4-03-**-***-14	SA4-03-**-***-15	SA4-06-**-***-10	SA4-06-**-***-11	SA4-06-**-***-12	SA4-06-**-***-13
22	7076	PIPE PLUG	1	1	1	1	1	1	1	1	1
23	225199	PLUG	1	1	1	1	1	1	1	1	1
24	223055	SPRING	1	1	1	1	1	1	1	1	1
25	177850	SCREW	3	3	3	3	3	3	3	3	3
26	177713	PLUG	1	1	1	1	1	1	1	1	1
*27	199812	"O" RING	1	1	1	1	1	1	1	1	1
28	223056	SPRING	1	1	1	1	1	1	1	1	1
29	229570	SPOOL					1	1	1	1	1
	220215	SPOOL	1	1	1	1	1				
30	7074	PIPE PLUG	2	2	2	2	2	2	2	2	2
31	164056	ROLL PIN	1	1	1	1	1	1	1	1	1
32	158577	SET SCREW	1	1	1	1	1	1	1	1	1
33	223045	ADJ. SCREW	1	1	1	1	1	1	1	1	1
*34	187681	"O" RING	1	1	1	1	1	1	1	1	1
35	223046	PLUG	1	1	1	1	1	1	1	1	1
36	936506	SLEEVE S. A.					1				
	936507	SLEEVE S. A.		1							
	936508	SLEEVE S. A.	1								
	938796	SLEEVE S. A.							1	1	1
	938797	SLEEVE S. A.			1	1	1				
37	229568	BODY						1	1		
	231623	BODY		1	1						
	223053	BODY	1								
	249754	BODY								1	
38	249755	BODY				1	1				
	227551	PLATE						1	1		
39	178993	PLATE	1	1	1						
	154005	"O" RING	4	4	4	4	4	4	4	4	4
*40	175942	"O" RING				6	6	6	6	6	6
	173792	"O" RING	6	6	6						
*41	235068	GASKET					1				
42	215396	SCREWS					4				



LITHO IN U.S.A.

ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES
SA4 - 03/06

TWO STAGE
TYPE

GENERAL DATA

This two-stage servo valve model provides the extremely accurate flow modulation and reversibility required for fast and precise closed loop control of position, velocity and acceleration.

The reliable, high performance first stage consists of a powerful torque motor and sliding spool pilot valve. Optimizing overall valve characteristics for any set of operating conditions is readily achieved through use of a unique variable fulcrum in the mechanical feedback linkage between the pilot and main stage sections.

Two sizes are available in this model series - 17 GPM and 37 GPM 1000 PSI drop.

FLUIDS AND TEMPERATURE DATA

For reference see Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400).

Petroleum Base Fluids

For best results, use 150 SSU (Light) at 100°F.

Fire Resistant Fluids

Note: Add F3 prefix to model code when phosphate esters or its blends are to be used.

Water based fluids cause altered performance characteristics and shortened life and are not recommended.

RATINGS

Supply Pressure (Maximum) 3000 PSI
Control Pressure 200-1000 PSI
Flow - (@ 1000 PSI Pressure Drop and Rated Current):
SA4-03-35-004-15 17 GPM
SA4-06-55-004-13 37 GPM
See Typical Curves for Other Flow, Pressure, Linkage Ratio Combinations.

Operating Temperature:

Nominal 120°F
Maximum 170°F

Filteration Recommended (Full Flow Pressure Line)

Dither ISO cleanliness code 15/11.
Hysteresis< 2 percent/°F
Deadband 0.2 percent with dither.
Temperature Null Shift (100°F to 150°F) 0.03 percent/°F
Frequency Response See characteristic curves.

The response for both the SA4-03 and SA4-06 valve models is substantially the same for a given linkage ratio.

Torque Motor Characteristics:

Coil Resistance (Ohms/Coil) 40 ohms
Input Current/Coil 150mA
Power Required For Series or Parallel Circuits 1.8 watts

FILTRATION

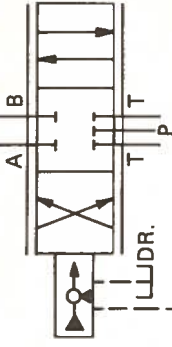
For satisfactory service life of this component, provide full flow system filtration. Filter selections from Vickers OFF, OFR and OFRS series are recommended. Refer to Section "P" - "Filters" and Section "S" - "Technical Information of Vickers Catalog 400 or contact your Vickers representative for further filtration advice.

WEIGHT

Valve - SA4-0* 15 lbs.
Subplates - SVG2-03 ... 11 lbs.
SVG2-06 ... 17 lbs.

SERVICE INFORMATION

Refer to specific Vickers part drawing or overhaul manual for service information. A complete "Index to Industrial Products Service Information" is included in the Technical Information section of Vickers Catalog 400.



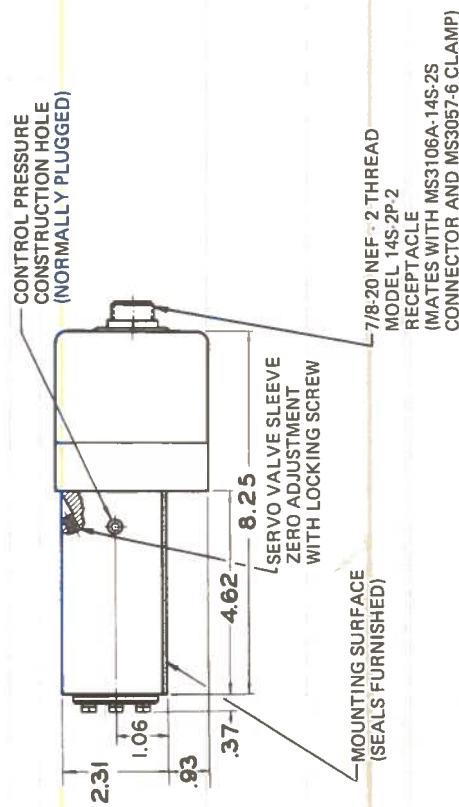
CONT. PR.

STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

F3-S A 4-03-35-004-10

1	2	3	4	5	6	7	8
1 Special Seals							
See "Fluids" note. Omit if not required.							
2 Servo Valve							
3 Type							
A - Two stage sliding spool.							
4 4-Way							
5 Nominal Pipe Size							
03 - 3/8 in. 06 - 3/4 in.							
6 Linkage Ratio							
55 - 5.5 to 1 50 - 5.0 to 1 45 - 4.5 to 1 40 - 4.0 to 1 35 - 3.5 to 1 30 - 3.0 to 1 25 - 2.5 to 1 20 - 2.0 to 1 15 - 1.5 to 1							
7 Nominal Coil Resistance							
004 - 40 ohms Other coil valves available upon request.							



Technical drawing of a valve assembly, showing a front view and a side view.

Front View Dimensions and Labels:

- Top Left:** CONTROL PRESSURE CONNECTION 1/8 NPTF
- Top Center:** 15/64 DIA. - 2 HOLES DRAIN PORTS
- Top Right:** 15/64 DIA. HOLE CONTROL PRESSURE PORT
- Center:** .343 DRILL - THRU .468 C BORE - .43 DEEP - 3 HOLES FOR MOUNTING SUBPLATE ONLY SEE TABULATION OF DIMENSIONS FOR PORT DIAMETERS.
- Bottom Left:** F (1.2570 DRILL .81 DEEP) .312-18 NC 2B TAP .56 DEEP 4 HOLES FOR MOUNTING SERVO VALVE. SEE VALVE DRAWING FOR LOCATIONS.
- Bottom Center:** TANK CONNECTION "H" NPTF
- Bottom Right:** PRESSURE CONNECTION "H" NPTF
- Dimensions:**
 - Top: .06, .62, .12
 - Left: 4.37, .75, .75, .37
 - Center: 1.44, 5.25, 1.94, .31, .47, .94, .78
 - Right: 1.59, 3.28, 4.56, C
 - Bottom: .12, .62, 1.375, L, K, J

Side View:

- Labels:** F, G, A, B
- Dimensions:** F, G

Model Numbers	Servo Valve Subplates												
	Ports					Dimensions							
	A	B	P	T	H Pipe Thd.	C	D	E	F	G	J	K	L
SVGM2-03-10	.38	.38	.44	.44	3/8	5.06	1.19	1.78	1.06	1.50	.47	.41	.125
SVGM2-06-10	.56	.56	.56	.56	3/4	5.38	1.50	1.62	1.50	2.25	.75	.75	1.38

= System Connection Sizes

BOLTS
Valves, subplates and mounting bolts must be ordered separately.

Example.
One (1) SA4-03-30-004-1* servo
valve
One (1) SVG2-03-10 subplate
One (1) BKSA4-628 bolt kit†

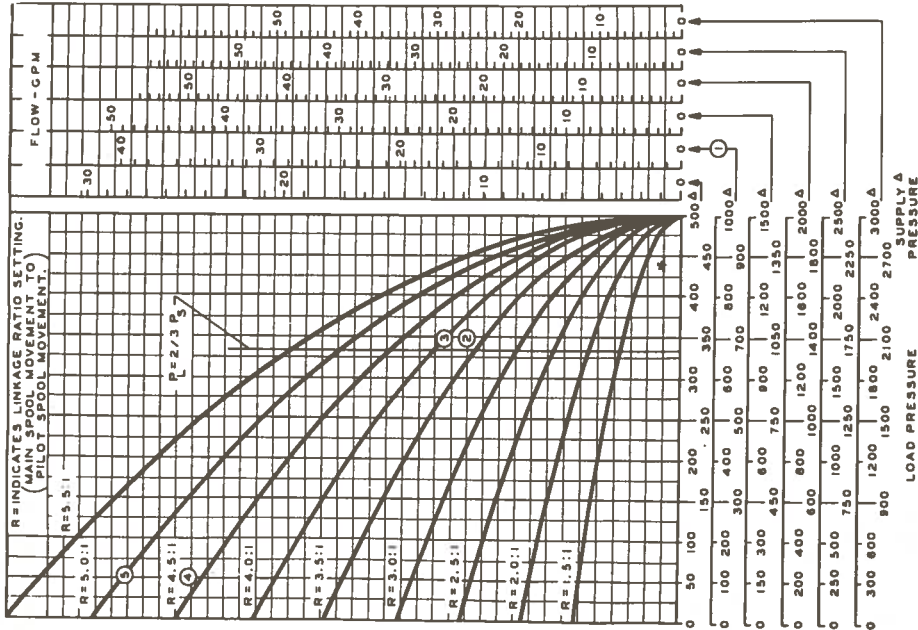
When subplate is not used, a machined pad (as indicated by subplate shaded area) must be provided for mounting; pad must be flat within .0005 inch and smooth within 63 microinch.

Mounting bolts, when provided by customer, should be SAE grade 7, or better.

† See "Bolt Kit" information in Section "Q" of Vickers Catalog 400 for bolt thread size and length.

TYPICAL PERFORMANCE CURVES Series SA4-03

THEORETICAL CURVES



THE ABOVE CHARTS CAN BE USED AS A GUIDE FOR THE SELECTION OF NOMINAL LINKAGE RATIO. LINKAGE RATIO IS EASILY ADJUSTED IN THE FIELD, IF REQUIRED, TO MEET SPECIFIC REQUIREMENTS. REFER TO MAINTENANCE BULLETIN I-3060-S.

EXAMPLE PROBLEM FOR SELECTING LINKAGE RATIO SETTING

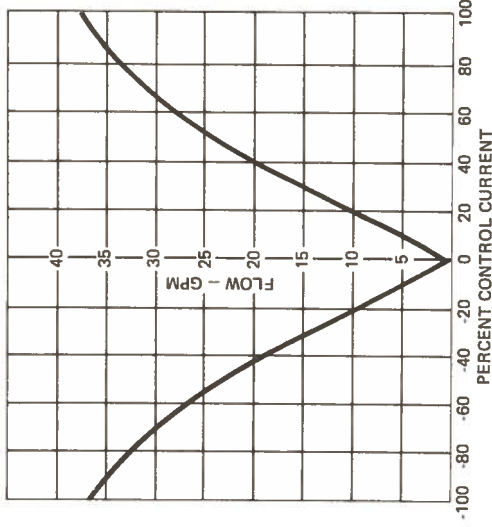
AVAILABLE SUPPLY PRESSURE = 1000 PSI
CUSTOMER LOAD SPECS. 15 GPM @ 700 PSI (WORK LOAD) - 35 GPM @ 100 PSI (TRAVERSE)

SOLUTION: STEPS MARKED ⊕ ON GRAPH

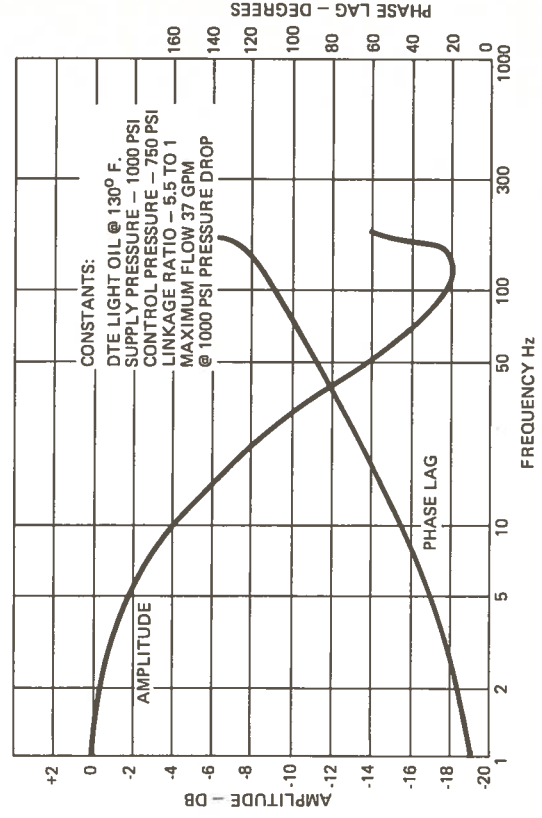
1. LOCATE PRESSURE - FLOW SCALES (1000)
2. FIND INTERSECTION OF WORK LOAD PRESSURE AND FLOW COORDINATES (P_L = 700 Q = 15)
3. MOVE UP TO NEAREST CURVE R = 4.0:1
4. FIND INTERSECTION POINT OF TRAVERSE CO-ORDINATES P_L = 100 Q = 35
5. MOVE UP TO NEAREST CURVE R = 5.0:1. USE 5.0:1 LINKAGE RATIO TO MEET BOTH SPECS.

TYPICAL FLOW

Constants:
Pressure drop 1000 PSI
Control pressure 750 PSI
Valve feedback ratio 3.5:1
DTE light oil @ 130°F



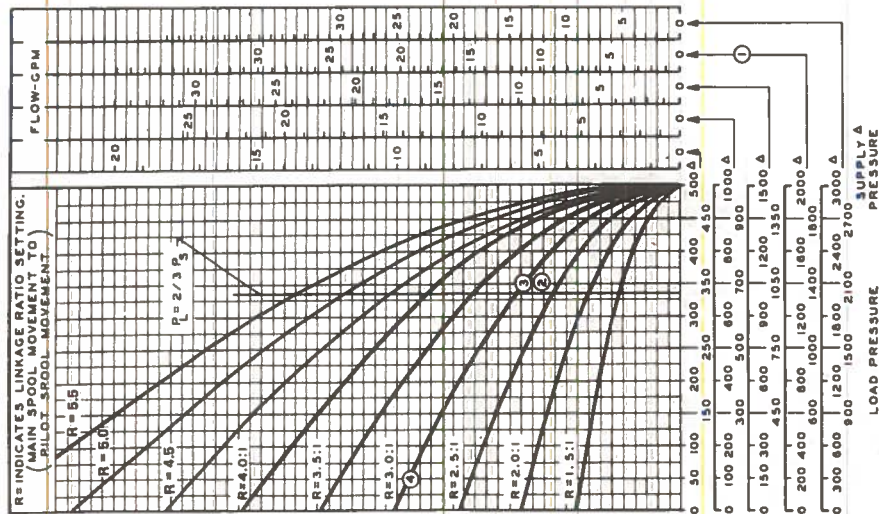
SINUSOIDAL RESPONSE CHARACTERISTICS



TYPICAL PERFORMANCE CURVES

Series SA4-03

THEORETICAL CURVES



THE ABOVE CHARTS CAN BE USED AS A GUIDE FOR THE SELECTION OF NOMINAL LINKAGE RATIO. LINKAGE RATIO IS EASILY ADJUSTED IN THE FIELD, IF REQUIRED, TO MEET SPECIFIC REQUIREMENTS. REFER TO MAINTENANCE BULLETIN I-3060-S.

EXAMPLE PROBLEM FOR SELECTING LINKAGE RATIO SETTING

AVAILABLE SUPPLY PRESSURE = 2000 PSI
CUSTOMER LOAD PRESSURE = 1400 PSI MAXIMUM; 200 PSI FOR RAPID TRAVERSE

DESIRED MAXIMUM FLOW UNDER LOAD = 10.0 GPM

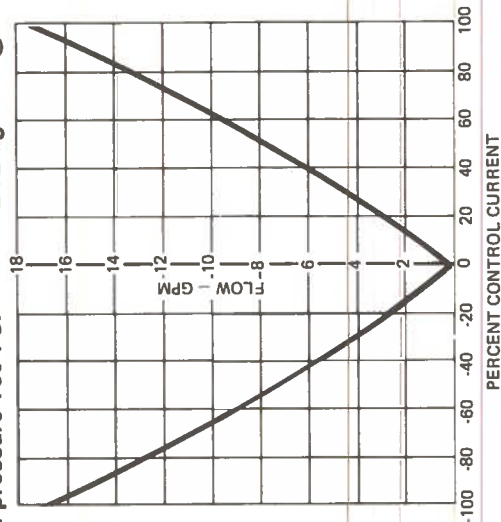
RAPID TRAVERSE FLOW REQ. = 18 GPM

SOLUTION: STEPS MARKED ⊕ ON GRAPH

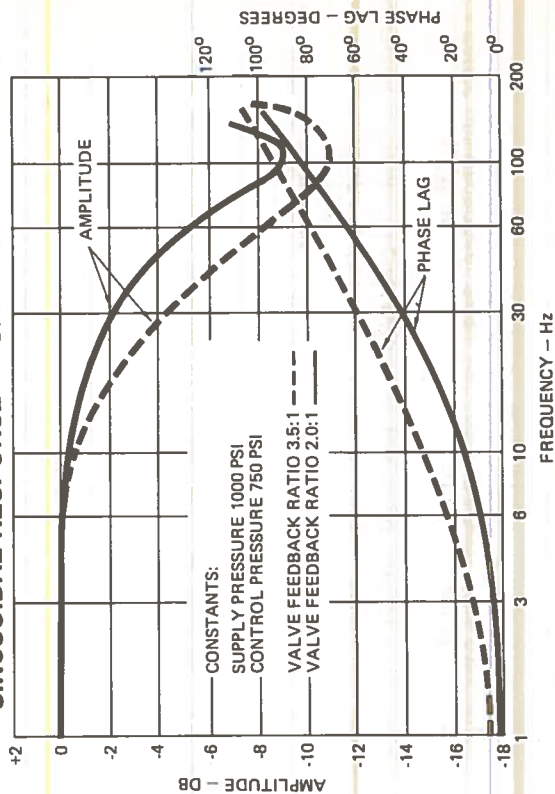
1. LOCATE PROPER PRESSURE AND FLOW SCALE (2000 PSI)
2. FIND INTERSECTION POINT OF LOAD PRESSURE AND FLOW CO-ORDINATES (P = 1400, Q = 10.0)
3. MOVE UP TO NEAREST CURVE R = 3.0:1
4. MOVE ALONG CURVE TO LOW PRESSURE (200) POINT. (Q = 19.3), USE 3.0:1 RATIO.

TYPICAL FLOW

Constants:
Pressure drop 1000 PSI
Control pressure 750 PSI
Valve feedback ratio 3.5:1
DTE light oil @ 130°F



SINUSOIDAL RESPONSE CHARACTERISTICS



I-501500-4

Revised 5-87

ELECTRO- HYDRAULIC

SERVO MANIFOLD

SERVO VALVES

GENERAL DATA

Used to adapt the SA type industrial servo valve to the MF-2003-A piston type motor.

This manifold provides close coupling and has a minimum amount of oil under compression.

This model includes cross line relief valves which provide peak overload protection for the hydraulic motor and a cross line variable orifice which can be adjusted for best viscous damping.

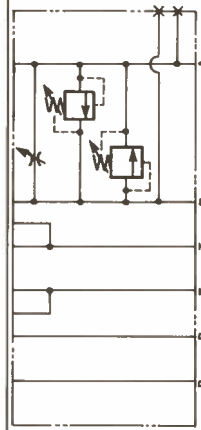
Cross line relief valves are especially recommended for any application where an overrunning load might occur.

WEIGHT

Manifold 1.7 kg (3.7 lbs.)

RATINGS

Maximum Operating Pressure	210 Bar (3000 PSI)
Volume of Oil Under Compression - Per Side	0.72 cu. in.



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

SVGM 1-A-03-10

12345

1 Servo Valve Manifold

03 - 30 series

Application **2**

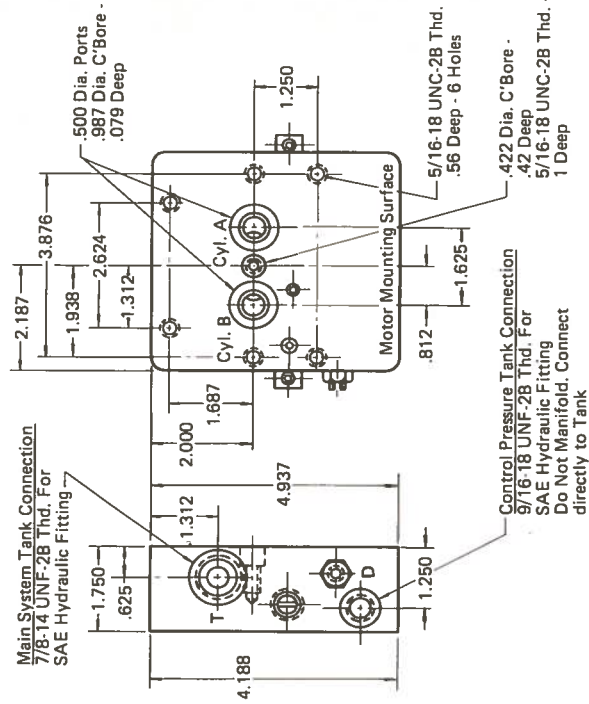
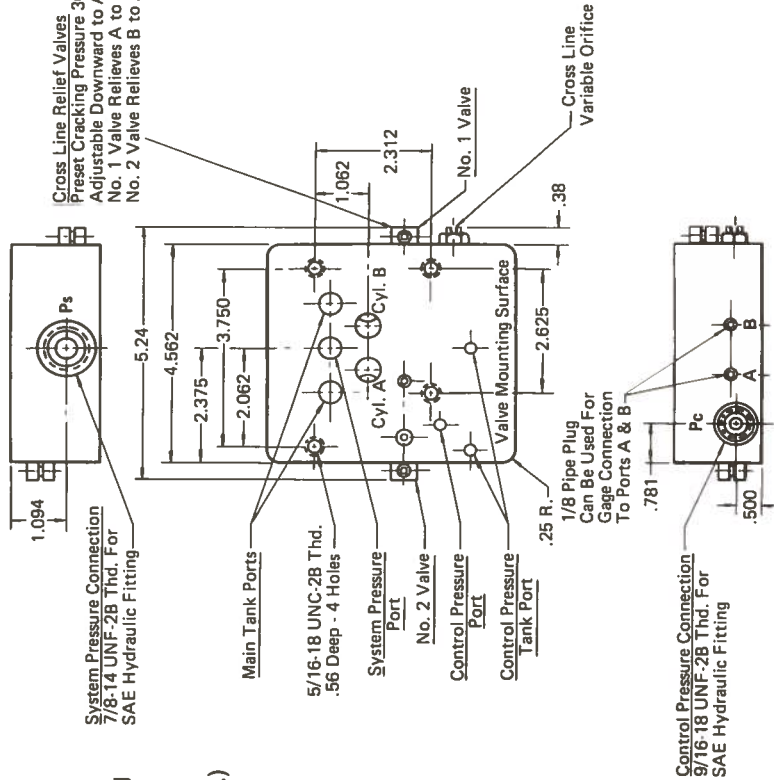
1 - SA4 - ** subplate

Type 3

A - Relief valves and cross-line orifices.

Design Number

Subject to change. Installation dimensions remain as shown for designs 10 through 19.





ELECTRO-HYDRAULIC SERVO VALVES

**MODEL SERIES
SVG M6**

SERVO MANIFOLDS

GENERAL DATA

Used to couple the series SA4-06 servo valve to MF-208A piston type servo motors.

Design permits compact coupling, thereby minimizing the volume of oil under compression between the motor and servo valve.

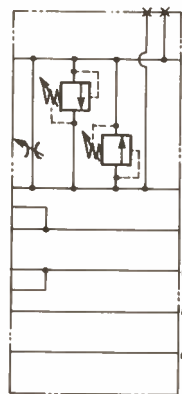
Cross line relief valves provide maximum protection against motor overload. Viscous damping is controlled by adjustment of the cross line variable orifice.

RATINGS

Maximum Operating Pressure	3000 PSI
Volume of Oil Under Compression (Per Side)	1.1 cu. in.

WEIGHT

Manifold 7.5 lbs.



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

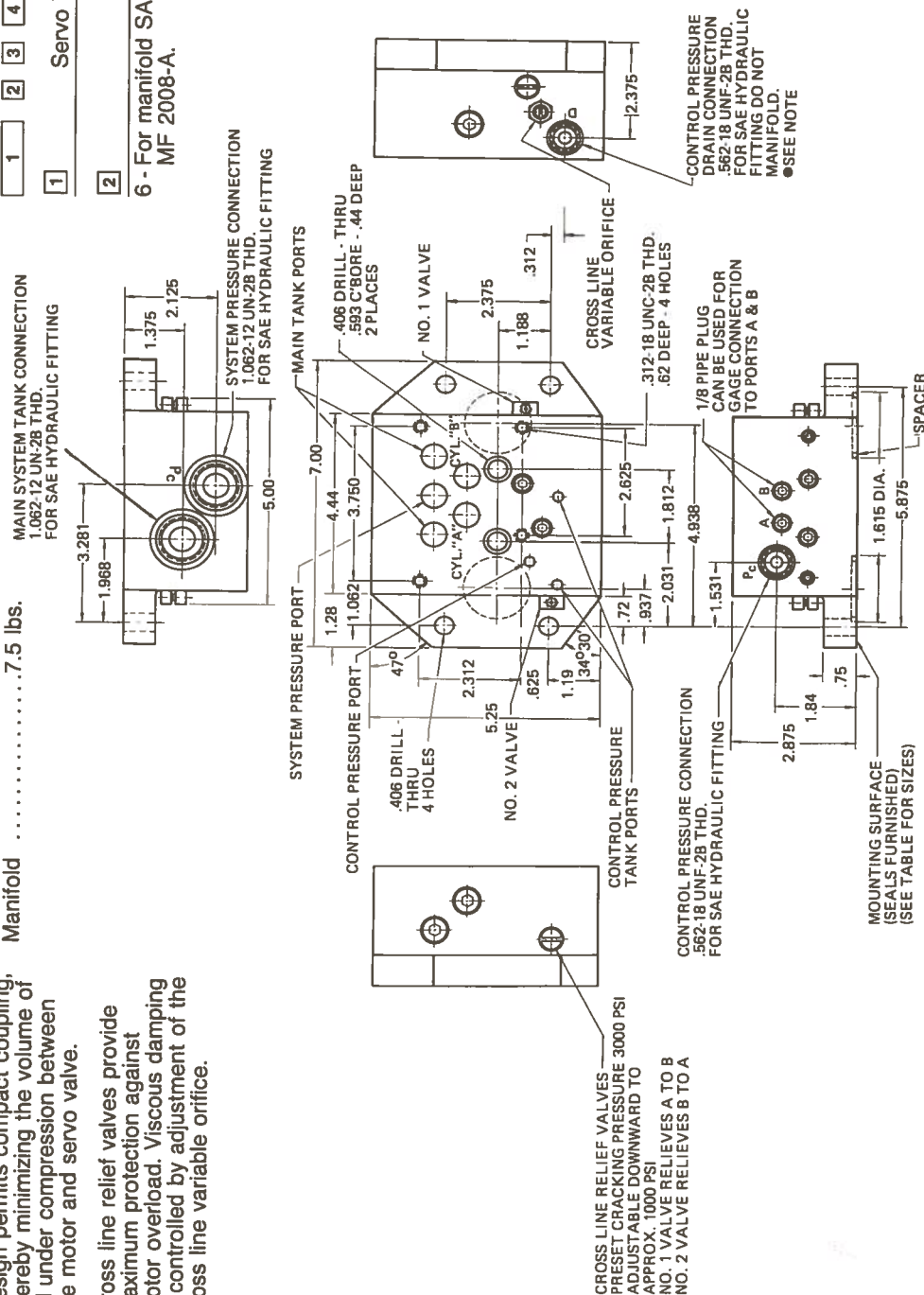
MODEL CODE

SVGM 6-A-06-10

1	2	3	4	5	Type
1	Servo Valve Manifold				3
2	Application				A - Relief valves and cross-line offices.
6 - For manifold SA4-06 to MF 2008-A.					4
					Series

Design Number
5

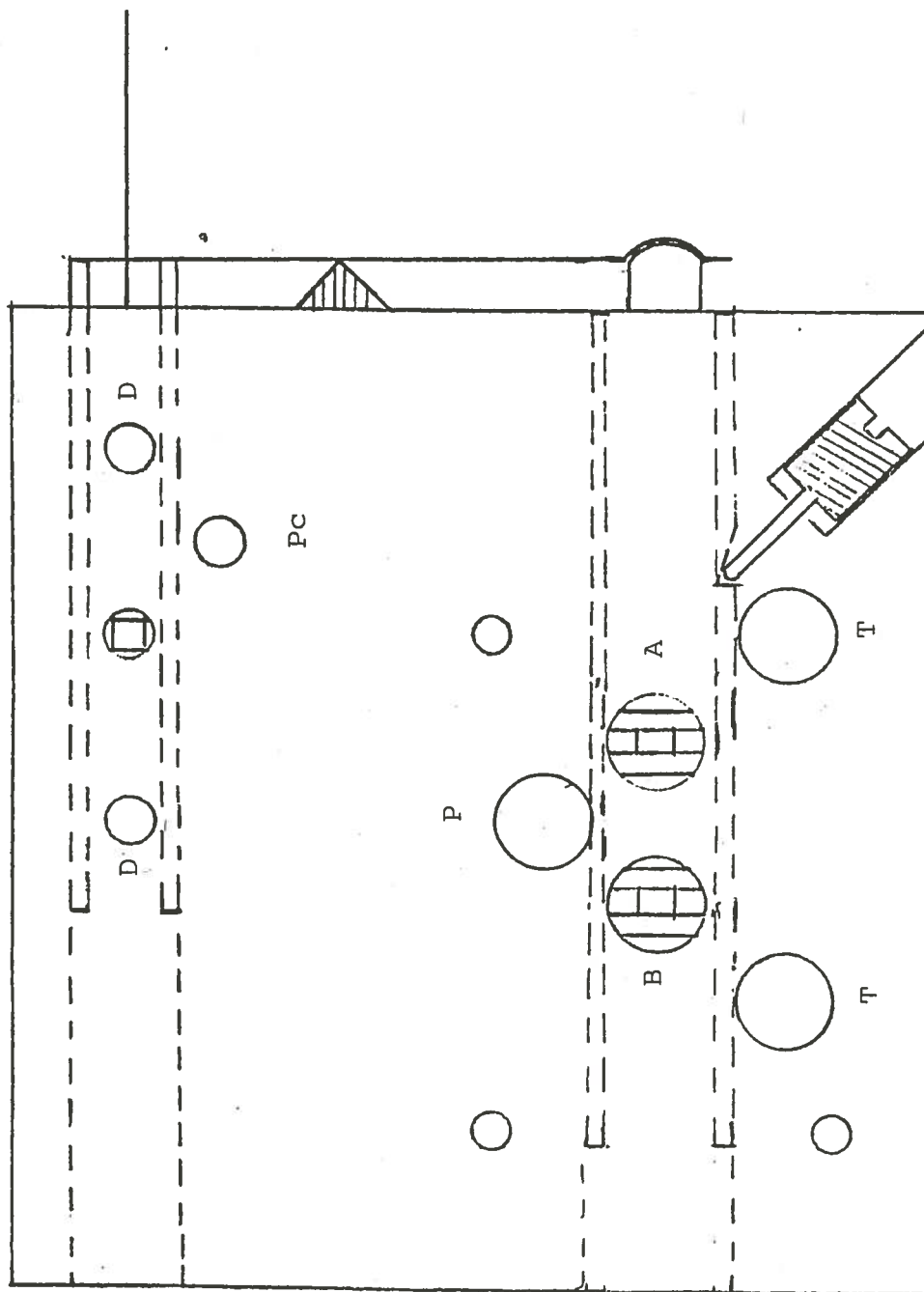
Subject to change. Installation dimensions remain as shown for designs 10 through 19.



● DRAIN LINE MUST BE FULL SIZE UNRESTRICTED & CONNECTED DIRECTLY TO RESERVOIR. NO OTHER LINES ARE TO BE CONNECTED TO THIS DRAIN LINE. PRESSURE IN THIS LINE (TAKEN AT THE VALVE) NOT TO EXCEED 5 PSI.

2. The pilot spool land should appear in the center of this port as shown

3. Adjust set screw wire, if necessary, to center pilot spool land.



1. Push in on spool here to center the spool lands in the ports as shown

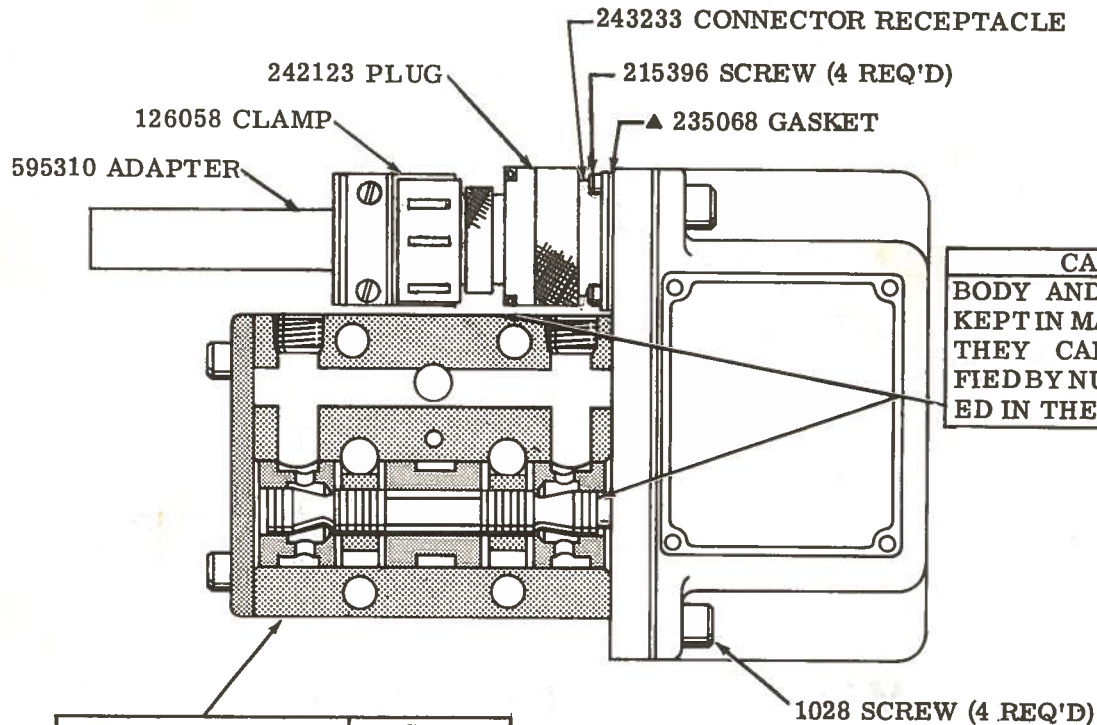


Service Parts Information

**SINGLE
STAGE
SERVO**

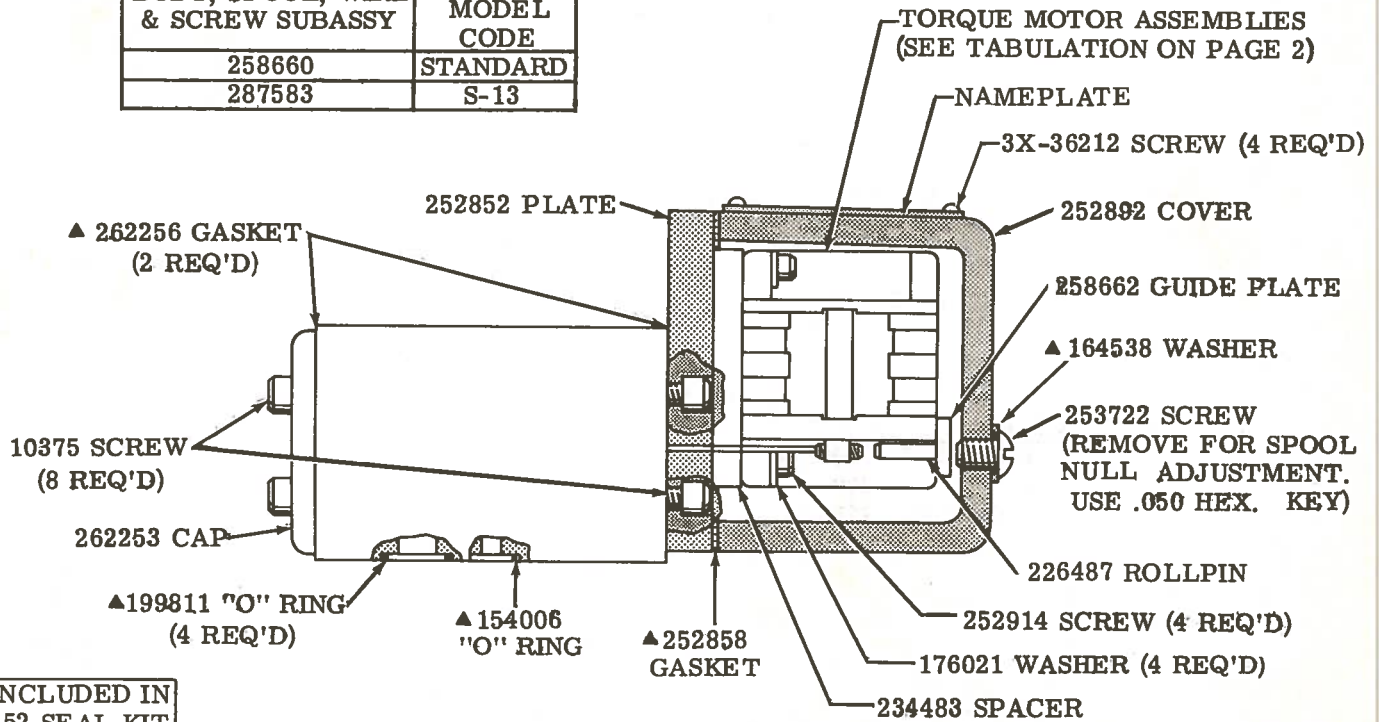
SC4-03-*-20(S**)**

5



CAUTION
BODY AND SPOOL TO BE KEPT IN MATCHED SETS. THEY CAN BE IDENTIFIED BY NUMBERS ETCHED IN THESE AREAS.

BODY, SPOOL, WIRE & SCREW SUBASSY	SEE MODEL CODE
258660	STANDARD
287583	S-13



▲ INCLUDED IN
919252 SEAL KIT

Vickers, Incorporated
1401 Crooks Road
Troy, Michigan 48084

Revised 3-1-85

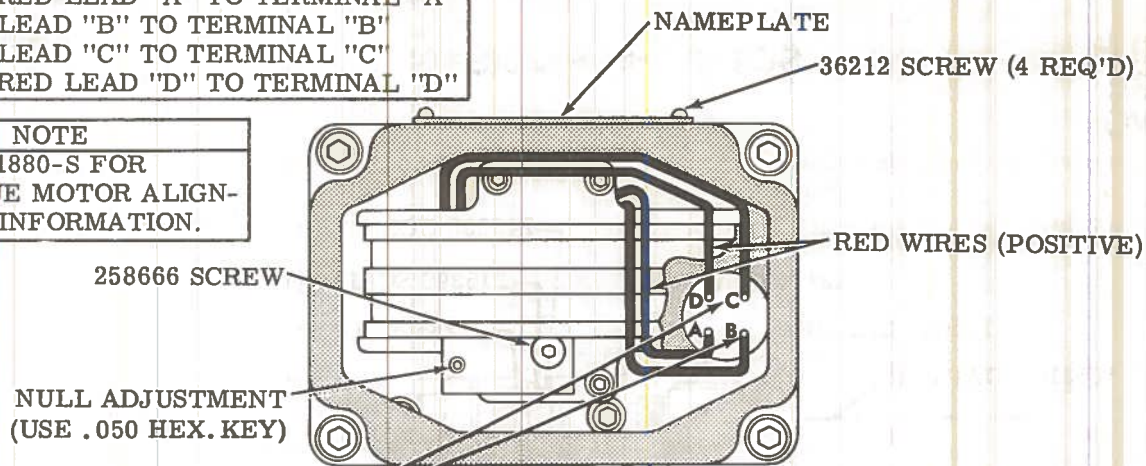
I-3061-S

COIL WIRING PROCEDURE

SOLDER RED LEAD "A" TO TERMINAL "A"
SOLDER LEAD "B" TO TERMINAL "B"
SOLDER LEAD "C" TO TERMINAL "C"
SOLDER RED LEAD "D" TO TERMINAL "D"

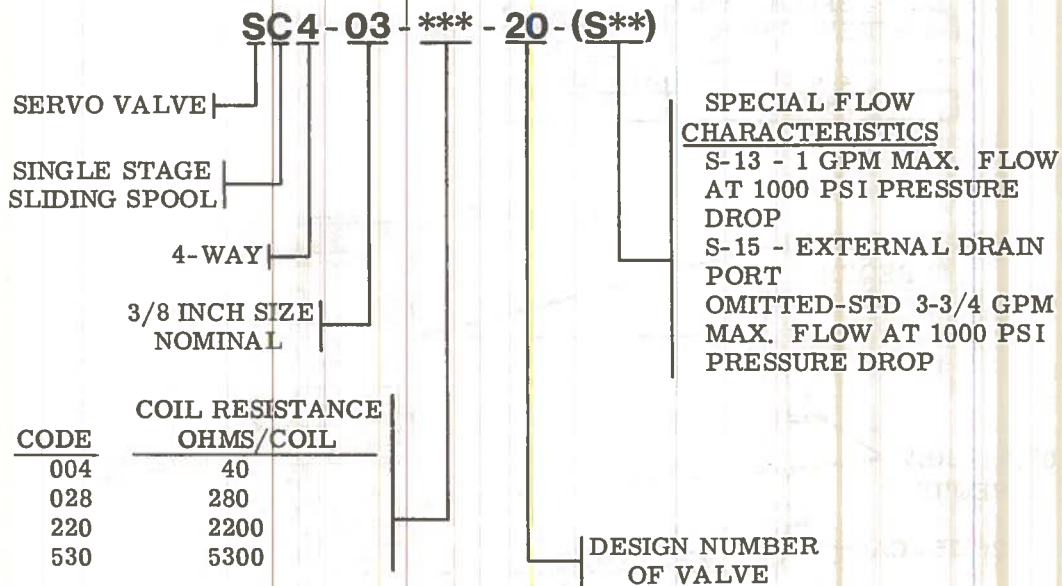
NOTE

SEE I-1880-S FOR
TORQUE MOTOR ALIGN-
MENT INFORMATION.



TORQUE MOTOR ASSY. NO.	WIRE COLORS AT TERMINALS "B" & "C"	NOMINAL CURRENT & RESISTANCE VALUES					
		RESISTANCE OHMS/COIL	DIFF. CONN. (PUSH PULL) MILLI-AMPS	PARALLEL CONNECTED		SERIES CONNECTED	
				RES.	CURR.	RES.	CURR.
212619	YELLOW	40	300	20	300	80	150
207691	WHITE	280	100	140	100	560	50
207692	BLUE	2200	40	1100	40	4400	20
211458	BLACK	5300	25	2650	25	10600	12.5

MODEL CODE BREAKDOWN



To insure sustained efficiency and maximum trouble free life of this precision equipment, initial and continuous full flow filtration of the fluid medium is essential. Select and apply filters from the Vickers OFP, OFR, and OFRS series, which are available in 3, 10, and 25 micrometre filtration ratings.

Litho in U. S. A.

ELECTRO-HYDRAULIC SERVO VALVES

MODEL SERIES
SC4 - 03

SINGLE STAGE
TYPE

GENERAL DATA

This single stage servo valve provides the flow modulation and reversibility required for fast and precise closed loop control of position, velocity and acceleration. A torque motor in the valve converts the electrical input signal directly to mechanical positioning of the valve spool. Features include excellent dynamic performance, simple construction, and straight-forward field serviceability. Refer to drawings 521540 and 519720 for power supply and amplifier data.

APPLICATION GUIDANCE

Drain

Drain must be piped directly to tank through a surge free line so there will be no back pressure at the valve drain port. Transient pressure must not exceed 5 PSI.

FLUIDS AND SEALS

The use of synthetic, fire resistant fluids require a valve with special seals. Note: add prefix "F3" to model number when phosphate esters or its blends are to be used (see model code).

FILTRATION

For satisfactory service life of this component, provide full flow system filtration. Filter selections from Vickers OFP, OFR and OFRS series are recommended. Refer to Section "p" - "Filters" and Section "S" - "Technical Information" of Vickers Catalog 400, or contact your Vickers representative for further filtration advice.

RATINGS

Supply Pressure (Maximum) 1000 PSI
Operating Temperature:
Nominal 120°F
Maximum 170°F
Filtration Recommended (Full Flow Pressure Line) ISO cleanliness code 15/11.
Dither (Required) 60 to 400 CPS
Max. Flow at 1000 PSI Pressure Drop 3-3/4 GPM
Hysteresis < 2 percent.
Pressure Deadband < 1 percent.
Torque Motor Characteristics:
Coil Resistance (Ohms/Coil) 40 ohms
Other coils available on request.
Input Current/Coil 150 mA
Power Required For Series or Parallel Circuits 1.8 watts

FLUIDS AND TEMPERATURE DATA

Oil viscosity ranging between 150 SSU and 225 SSU at 100°F, for ambient temperatures above 65°F, is recommended. Maximum safe operating temperature, 170°F. Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations" (included in the Technical Information section of Vickers Catalog 400) for hydraulic fluid and temperature recommendations.

WEIGHT

Valve 8 lbs.
Subplate 4-1/2 lbs.

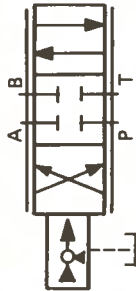
SERVICE INFORMATION

Refer to specific Vickers part drawing or overhaul manual for service information. A complete "Index to Industrial Products Service Information" is included in the Technical Information section of Vickers Catalog 400.



VICKERS, INCORPORATED
A TRINOVA COMPANY
Troy, MI 48064

SERVO



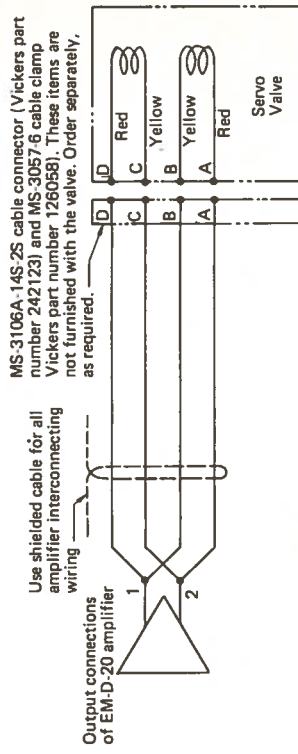
STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

F3-S C 4-03-004-20

1	2	3	4	5	6	7	
F3	- See "Fluids and Seals" note.	Blank - Omit if not required.	004 - 4 ohms	Other coil values available upon request.	03 - 3/8 in.	Nominal Pipe Size	
2							
3							
C - Single Stage							
4							
4 - 4-way							

WIRING DIAGRAM AND DESCRIPTION



When Amplifier Output at Terminal 1, With Respect to 2, is:	Servo Valve Output Flow Increases at Port:
Positive	B
Negative	A

SINGLE STAGE TYPE

INSTALLATION DATA

ELECTROHYDRAULIC SERVO VALVES

3/8" PIPING SIZE

MANIFOLD OR SUBPLATE MOUNTING

DWG. NO. I-519500

Revised 5-87



GLOSSARY
FOR
INDUSTRIAL
ELECTRO
HYDRAULIC
SERVO
VALVES

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PREFACE

Possibly one of the greatest aids to progress in any relatively new technology is to make certain that all persons involved are communicating in the same language. This is the purpose of the GLOSSARY FOR INDUSTRIAL ELECTROHYDRAULIC SERVO VALVES.

The following definitions have been developed by the Machinery Hydraulics Division of Vickers to provide a ready reference to the most commonly used terms.

We hope you will find it useful.



TYPES OF VALVES

Directional Valve - A valve that controls the direction of fluid flow in a circuit.

Four-Way Valve - A valve with 4 flow paths and 4 ports (inlet, outlets 1 and 2, and tank). In one valve spool position, the valve directs flow from inlet to outlet 1 and from outlet 2 to tank; in the other position, it directs flow from inlet to outlet 2 and from outlet 1 to tank.

Flow Control Valve - A valve that controls the rate of fluid flow in a circuit.

Electrohydraulic Servo Valve - A valve that controls both direction and flow rate in response to an electrical input signal.

ELECTRICAL CHARACTERISTICS OF SERVO VALVES

Torque Motor - A device used to provide mechanical motion to the first stage of a servo valve in response to an electrical input signal. The amount of motion is generally proportional to the size of the input signal.

Input Signal - The input voltage or current supplied to the torque motor from a control circuit.

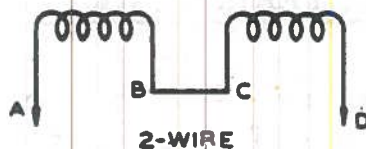
Input Current - The input signal, expressed in milliamperes (ma). One milliampere equals 0.001 ampere.

Rated Current - The input current required to produce rated output flow of the valve. This is usually expressed as differential current, but the valve may be used with any of the connections shown below:

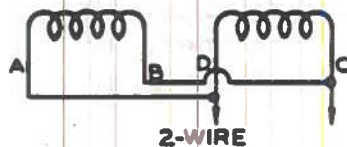
Differential - The difference between the currents in the two coils in a 3 or 4 lead differential coil connection.



Series - With the coils in series, rated flow will be obtained with an input current of $1/2$ the rated differential current.



Parallel - With the coils in parallel, rated flow will be obtained with an input line current equal to the differential current.



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Quiescent Current - The current required in each valve coil for zero flow from the valve.

Control Power

Differential - The product of the square of the differential current times the resistance of one coil.

Series - The product of the square of the series input current times the sum of the resistance of both coils.

Parallel - The product of the square of $1/2$ the input line current times the sum of the resistance of both coils.

Coil Resistance - The dc resistance of each torque motor coil expressed in ohms and measured at an ambient temperature of 68°F .

Coil Impedance - The ratio of coil voltage to coil current. This may vary with input signal frequency, amplitude, and other operating conditions due to back EMF generated by the moving torque motor armature.

Polarity - The relationship between the direction of valve output flow and the direction of current.

Dither - An ac electrical signal superimposed on the input signal to reduce the deadband of the valve. Dither is expressed by the dither frequency (cps) and the peak-to-peak dither current amplitude (ma).

STATIC PERFORMANCE

Output Flow - The flow through the valve ports, expressed in gpm. Flow is referred to as No Load Flow when there is zero load pressure. Flow is referred to as Load Flow when there is a load connected to the valve.

No Load Flow - The flow resulting when full supply pressure is dropped across the valve metering orifices. Flow will vary with a change in supply pressure as follows:

$$\frac{Q_1}{Q_2} = \sqrt{\frac{P_1}{P_2}}$$

Load Flow - The flow resulting when there is a load pressure applied to the valve. The load flow with rated current for any given load pressure will vary depending upon the valve design, but may be approximated by the following formula:

$$Q_L = Q_{NL} \sqrt{\frac{P_s - P_L}{P_s}}$$

Q_L = Load Flow (gpm)

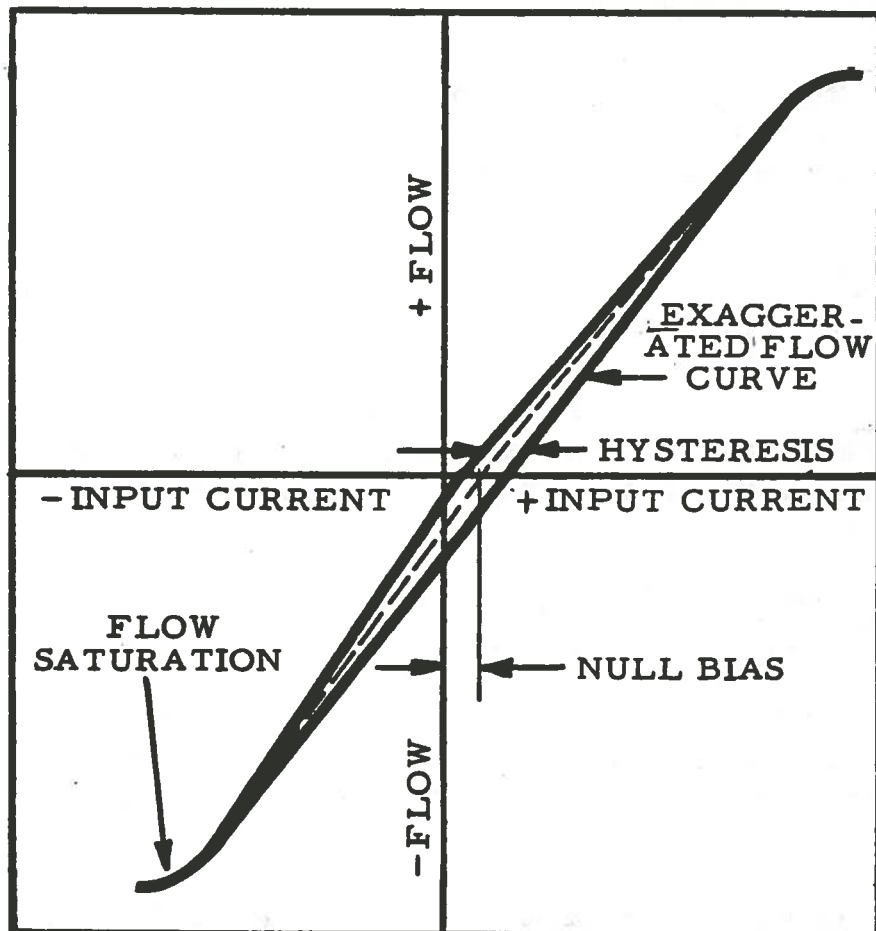
Q_{NL} = No-load Flow (gpm)

P_s = Effective Supply Pressure (psi)
(Supply pressure minus return pressure)

P_L = Load Pressure (psi)

Rated Flow - Flow at a specified pressure drop across valve, generally 1000 psi for industrial servo valves.

Flow Curve - The graphic representation of flow vs. input current. This is usually a continuous plot of a complete cycle between $\pm$ rated current values.



Flow Gain - The rate of change of flow with respect to input current, or the slope of the flow curve, expressed in gpm/ma.

Flow Saturation - The region of the flow curve where flow gain decreases with increasing input current.

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Hysteresis - The difference between increasing and decreasing input currents required to produce the same output when the valve is cycled over its full operating range. The difference in current is normally measured at zero flow and is expressed as a percent of rated current.

Threshold - The increment of input current required to produce a change in valve output in an established direction, expressed as percent of rated current.

Deadband - The increment of input current required to change the direction of output flow, expressed as percent of rated current.

Internal Leakage - The total internal valve flow from pressure port to tank port at zero input current with the output ports blocked, expressed in cubic inches per minute.

Load Pressure - The differential pressure between the output ports, expressed in psi.

Valve Pressure Drop - The sum of the pressure drops across the output stage, expressed in psi. Valve pressure drop equals the supply pressure minus the load and tank pressures.

Pressure Gain - The ratio of the change in load pressure to the change in input current with the outlet ports blocked, expressed in psi/ma.

Null - The condition where the valve supplies zero flow at zero load pressure.

Null Pressure - The pressure existing at both output ports at null, expressed in psi.

Null Bias - The input current required to bring the valve to null, excluding the effects of valve hysteresis, expressed as percent of rated current.

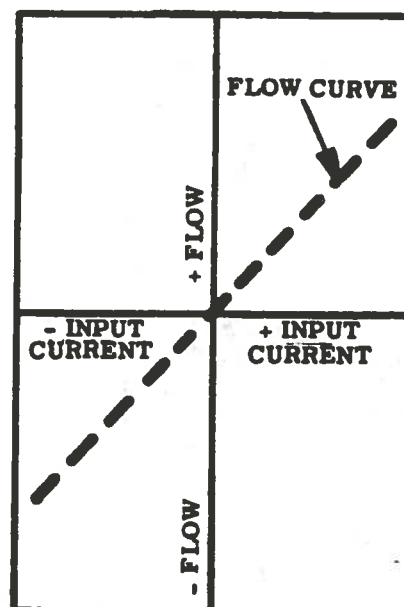
Null Shift - The change in null bias, expressed as percent of rated current. Null shift may occur with changes in supply pressure, temperature, and other operating conditions. Null shift is normally measured as follows:

Temperature - Measured in percent of rated current per degree F change in temperature.

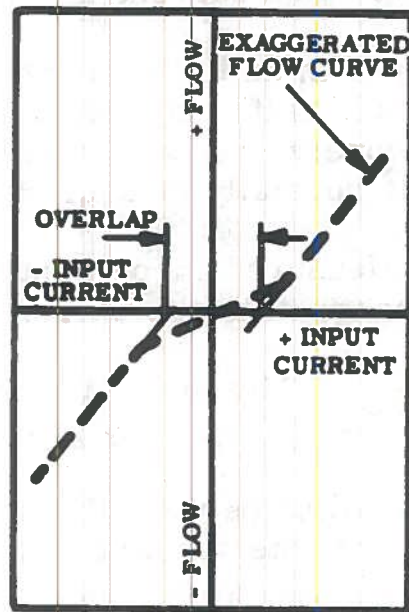
Supply Pressure - Measured in percent of rated current per psi change in supply pressure.

Lap - The relative position between the fixed and movable flow metering edges with the spool at null.

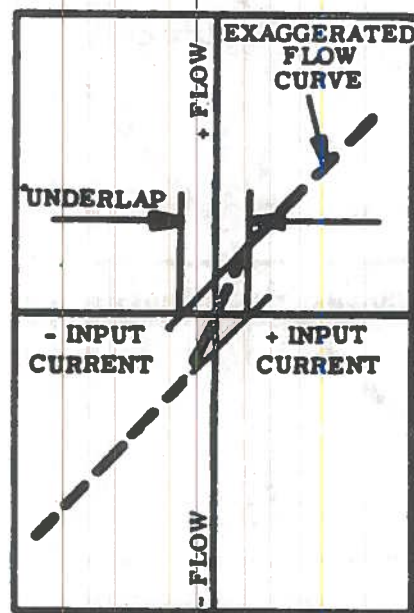
Zero Lap - The lap condition where the spool land exactly covers the port--commonly called line-to-line. Typical flow characteristics are:



Overlap - The lap condition where the spool land width is greater than the port width. Typical flow characteristics are:



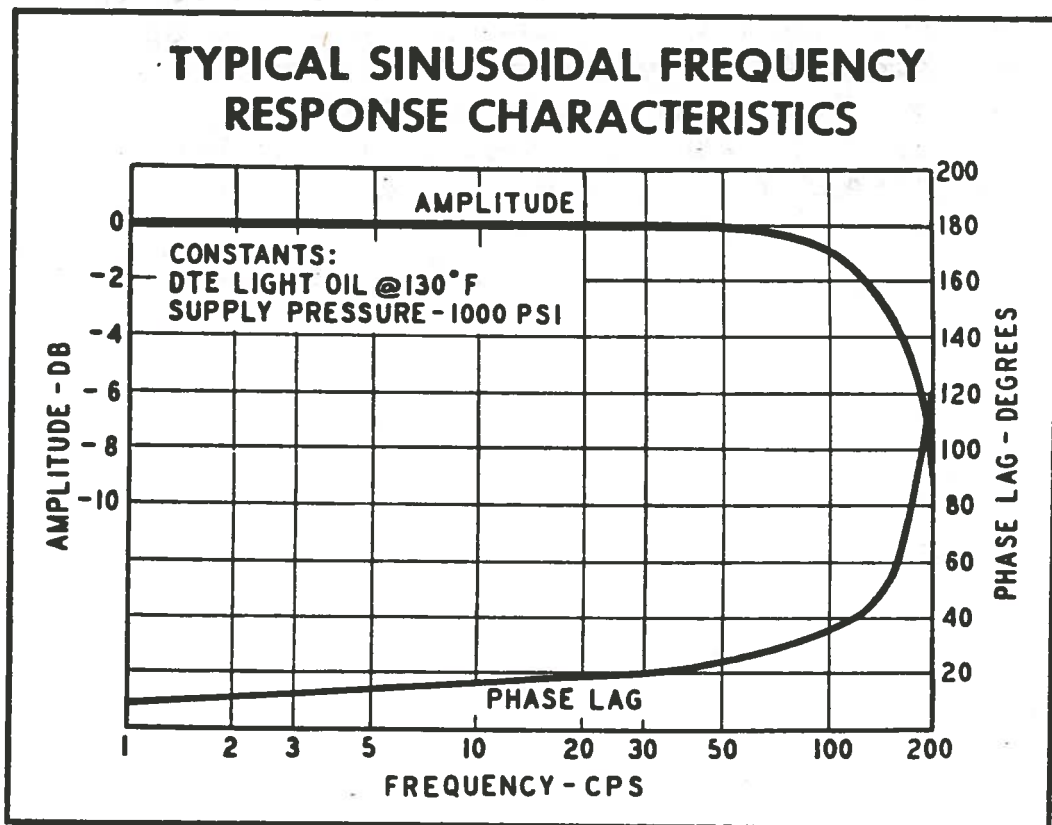
Underlap - The lap condition where the spool land width is less than the port width. Typical flow characteristics are:



DYNAMIC PERFORMANCE

In order to know how quickly and accurately a servo valve will respond to changes in input signal, and how well the valve will perform in a control system, its dynamic properties must be obtained. This is done by running a frequency response test over a range of frequencies from near zero to the point where the valve can no longer follow. A sinusoidal input signal of constant amplitude is applied and the output flow at zero load pressure is measured.

Frequency Response - The relationship of amplitude ratio and phase lag to frequency.



Amplitude Ratio - The ratio of the sinusoidal amplitude of output flow at a specific frequency to the output flow at a lower (basic) frequency with the same input signal. The amplitude is expressed in decibels from the following formula:

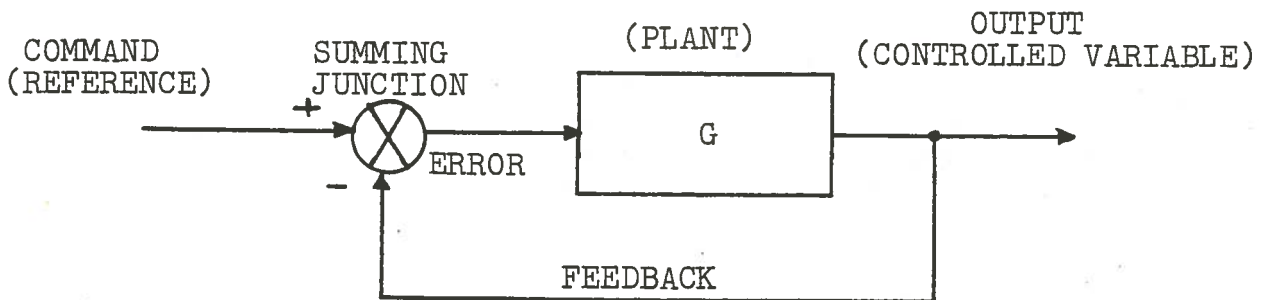
$$db = 20 \log_{10} AR$$

$$\text{where } AR = \frac{\text{Output at frequency } f}{\text{Output at base frequency}}$$

Phase Lag - The amount of time the output flow lags the sinusoidal input signal, expressed in degrees. The frequency at which a 90° phase lag occurs is one of the standards used in comparing the performance of servo valves. Total phase lag of all components in a closed loop servo system contributes directly to the degree of stability and accuracy of the system.

BASIC CONCEPTS OF SERVO SYSTEMSGENERAL

The electro-hydraulic servo system is one configuration of a general category called feedback control systems. In a feedback control system, the output (called the controlled variable) is sampled and sent back to the system input where it is compared to the command signal (reference) see Figure 1. If a difference exists between the command and output, an error signal develops which is processed through the forward loop element G (plant).

FIGURE 1

The output, thus, changes to achieve the commanded value. Any tendency for the output to change value will cause an error signal to develop, forcing the output to remain at the commanded value.

In a physical system, the output (controlled variable) and the input (reference) can be of various forms. For example, the variable to be controlled may be position, velocity, acceleration, pressure, heat...etc.. One qualification, however, is that the form of the command and feedback be the same where the comparison is being made (summing junction). For example, if the command is a physical position, the feedback must be a physical position. The command may be a voltage which represents a physical position but then the feedback must be a voltage which represents a physical position.

Notice also that the feedback is shown as being negative with respect to the command. This is a necessary condition for correct (stable) operation of the system. Otherwise, the command and feedback would be additive such that an ever increasing error signal would be developed.

Before looking specifically at the electro-hydraulic servo system it may be of interest to consider some other feedback control systems.

FEEDBACK CONTROL SYSTEM AT HOME

A rather common feedback control system is the automatic heat system found in homes (see Figure 2). The block diagram is simplified to emphasize the feedback concept, whereas in reality the system usually includes fan control and a second control loop within the furnace (plant) to prevent overheating of the furnace. Setting the thermostat to the desired temperature positions a bi-metal element. If the room temperature is below the commanded value, an electrical switch is activated supplying power to the gas valve. The valve opens allowing gas to flow to the burner and be ignited by the pilot flame. Heat generated by the burning of the gas heats the room. The room heat causes the bi-metal element in the thermostat to re-position and open the electrical switch once the commanded temperature is reached. The gas valve thus closes and the flame extinguishes.

AN ELECTRONIC FEEDBACK CONTROL SYSTEM

For those with electronics exposure, we remind you of the transistor regulators sometimes used on the output of D.C. power supplies. Figure 3 shows one possibility. (Conventional current flow is assumed-electron flow would be in the opposite direction.)

In order to examine the operation, let's assume the load increases (load resistance decreases). If load current remained the same, the output voltage would decrease ($E = IR$). The nature of the transistor however, is to maintain a fixed voltage difference between the base and emitter. (For silicon transistors, the difference is approximately 0.7 volts.) Also in the circuit we see that the base voltage is fixed by the zener diode. The emitter voltage, which is the output voltage, thus remains the same which means that the load current must increase (again $E = IR$). This is exactly what happens. Transistor base current I_B increases resulting in a proportional increase in emitter current (output current).

A simplified way of looking at the regulator circuit is to consider the transistor in this circuit as a variable resistor. As load resistance decreases, the output voltage would tend to decrease but the effective transistor resistance will also decrease, resulting in a constant output voltage.

HYDRAULIC FEEDBACK CONTROL SYSTEM

Figure 4 shows a hydraulic feedback control system. The controlled variable is the position of the cylinder. When the spool of the control valve is moved to a new position, say to the right, the

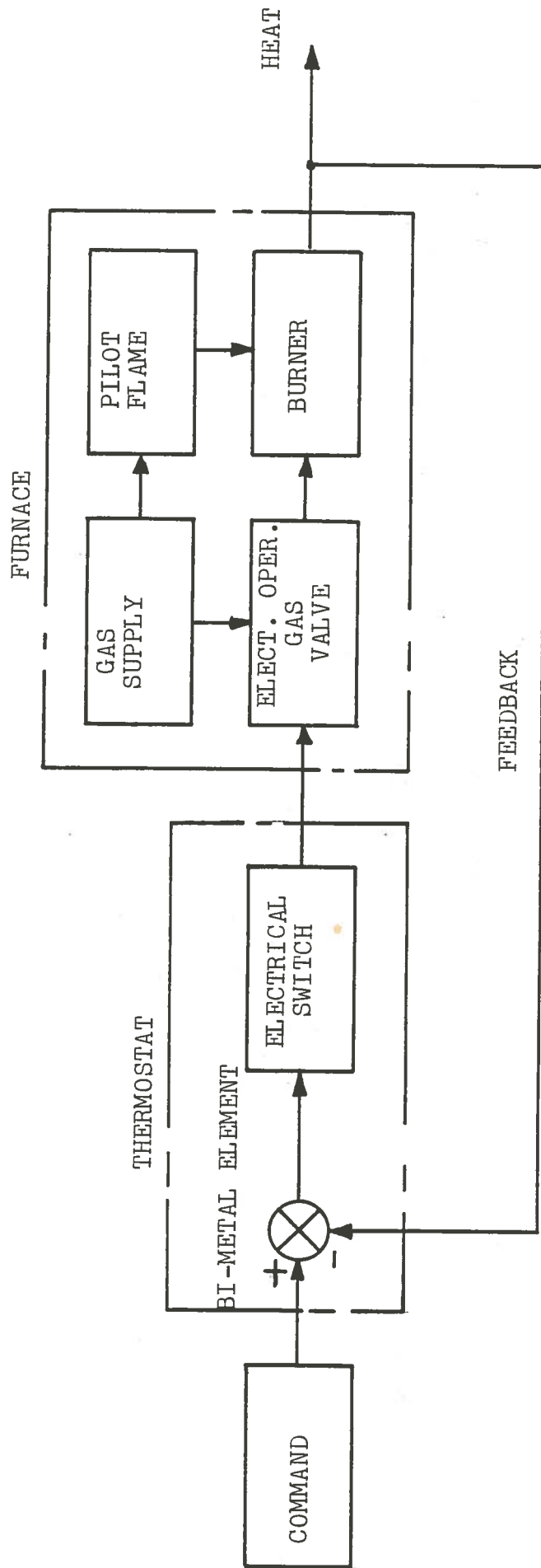


FIGURE 2 - Home Heat Feedback Control System

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opening created, ports oil from the pressure port (P) through the cylinder port (B) to the cylinder. Exhaust oil flow from the rod end of the cylinder flows through the opposite cylinder port (A) to tank (T). As the cylinder moves to the right, it pulls the sleeve within the control valve to shut off the ports. As a consequence of this arrangement, the cylinder will move to a position related to the spool position. Notice that this system has unity feedback which means the cylinder moves exactly the same distance that the control valve spool moves.

This system would appear to be the simplest and most desirable arrangement for positioning a hydraulic cylinder. There are limitations, however. For example, if the control valve spool total travel was one inch, the hydraulic cylinder could only be positioned within one inch of travel. Changing the feedback linkage ratio could improve the situation, so let's take a ratio of 10:1. Now, for every inch of spool travel, the cylinder would move 10 inches. Accuracy of position now suffers. If, because of the load, the cylinder, moved out of position .001", the sleeve in the valve would only open .0001". This may not be enough of an opening to generate an error signal (pressure) which would prevent the cylinder from moving out of position. (Refer to the Hydraulic Actuators article CTS-140-S for an explanation of pressure change.)

Changing the feedback ratio so that the sleeve moves 10 times as far as the cylinder will improve the accuracy. Now a 0.001" movement of the cylinder results in a .01" movement of the sleeve. However, total travel of the cylinder is now limited to 0.1".

Is there a way out of this dilemma? Yes!!!

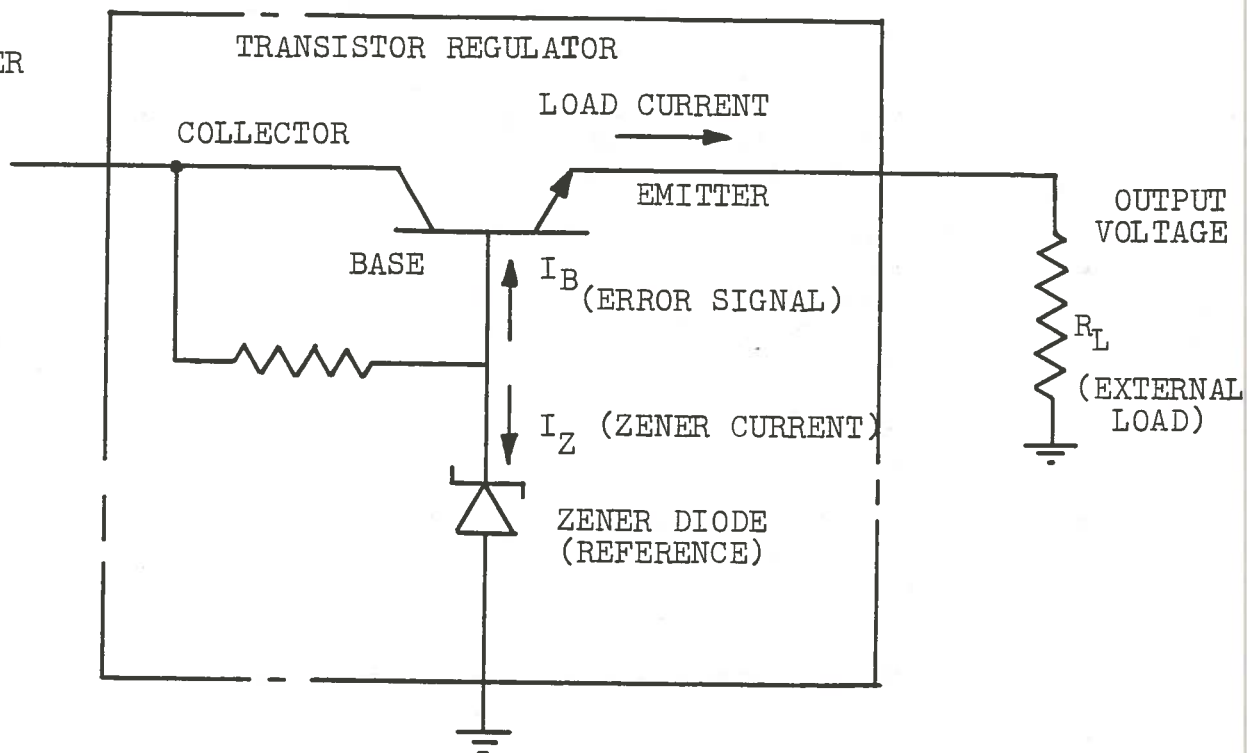
The problem here is the poor "gain" characteristic of the system. We need a system in which a small position error can be detected and amplified sufficiently to provide correction.

Electronics provides us with the answer because of virtually unlimited gain possibilities. This, then, is the reason for the marriage of electronics and hydraulics in one system.

ELECTRO-HYDRAULIC SERVO SYSTEM

As stated before, a feedback control system can be used to control various parameters (position, speed, acceleration...etc.). The two most commonly controlled variables in Electro-Hydraulic Systems are position and velocity. We will concentrate on these two systems and for the moment use block diagrams to show the concept.

D.C. FROM POWER
SUPPLY



SIMPLIFIED EQUIVALENT

D.C. FROM
POWER SUPPLY

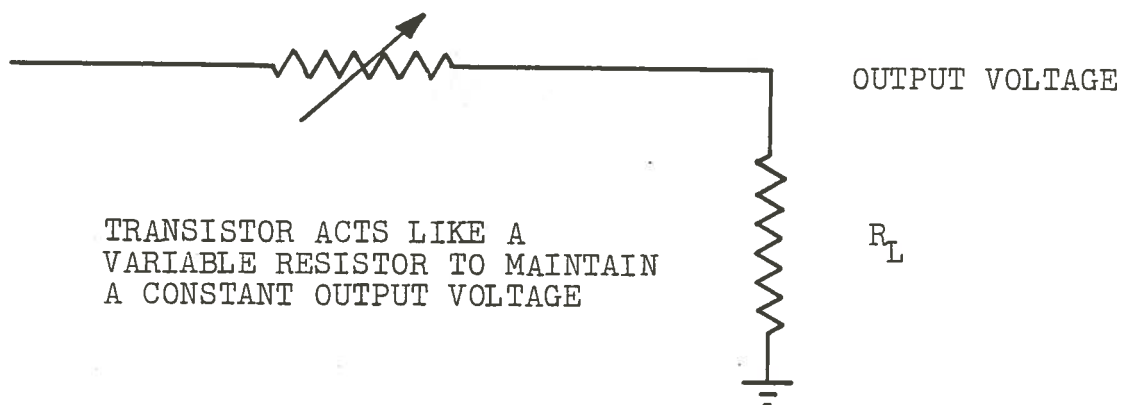


FIGURE 3 - An Electronic Feedback Control

SERVO VALVE POSITIONING SYSTEM

In Figure 5 the electrical command signal which represents a position is compared with the actual position of the load. If a discrepancy exists, an error signal develops which is sensed by the amplifier. The amplifier provides an output current which opens the servo valve which, in turn, ports oil to the hydraulic cylinder. As the cylinder moves to the new position, an electrical feedback device sends a position signal back to the summing junction. When the sum of the command and feedback signal is equal to zero, the amplifier senses no input and provides no output current. The centering mechanism in the servo valve causes it to center, blocking the hydraulic flow and the cylinder is stopped in its new position.

SERVO VALVE VELOCITY CONTROL SYSTEM

The velocity control system is essentially the same as the positioning system if we look only at the block diagram. (See Figure 6) There is a difference in reality. The feedback element sends a signal back to the summing junction which is proportional to velocity rather than position. A comparison is again made at the summing junction. If there is a difference between commanded velocity and actual velocity, an error signal develops and the amplifier output current changes to reposition the servo valve spool. The amount of oil flow through the servo is thus modulated to adjust the hydraulic motor speed.

Notice that once the hydraulic motor reaches the commanded speed, the sum of command and feedback would apparently be zero.

As before (in the positioning system) we might think that the amplifier output current would go to zero and the servo valve would close. If this happened, the hydraulic motor would stop which is not what we want to happen. The servo valve must be open an amount proportional to the speed desired. To accomplish this, the system must always run with a velocity error signal or something else must be done. In the system described, we find that it would generally be unstable with a constant error signal. A different type of amplifier called an "integrating" amplifier is usually used with the velocity control system allowing it to operate with a zero velocity error.

The amplifiers and other hardware for the systems are discussed in the appropriate sections of the book.

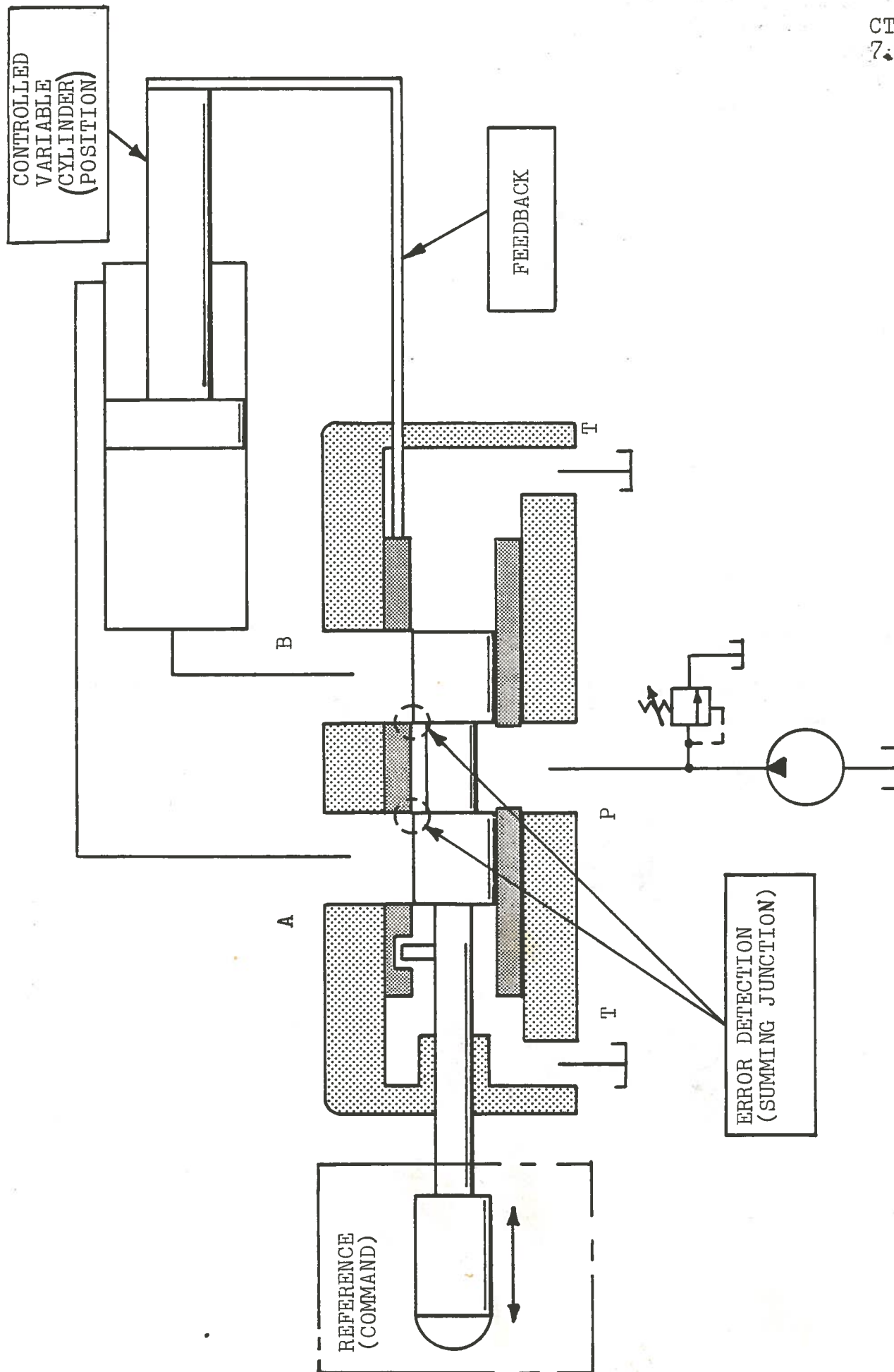


FIGURE 4 - Hydraulic Feedback Control System

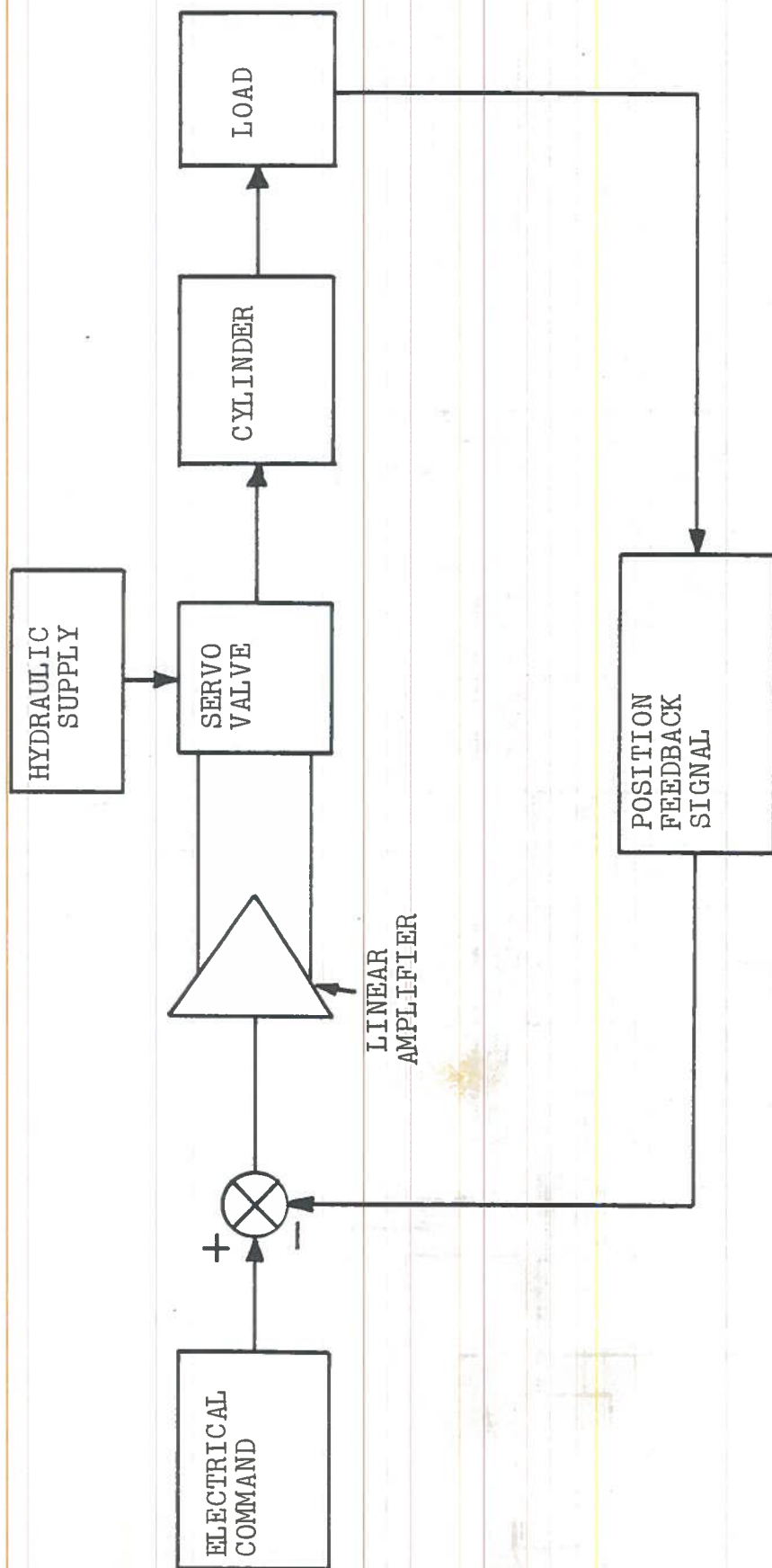


FIGURE 5 - Servo Valve Positioning System

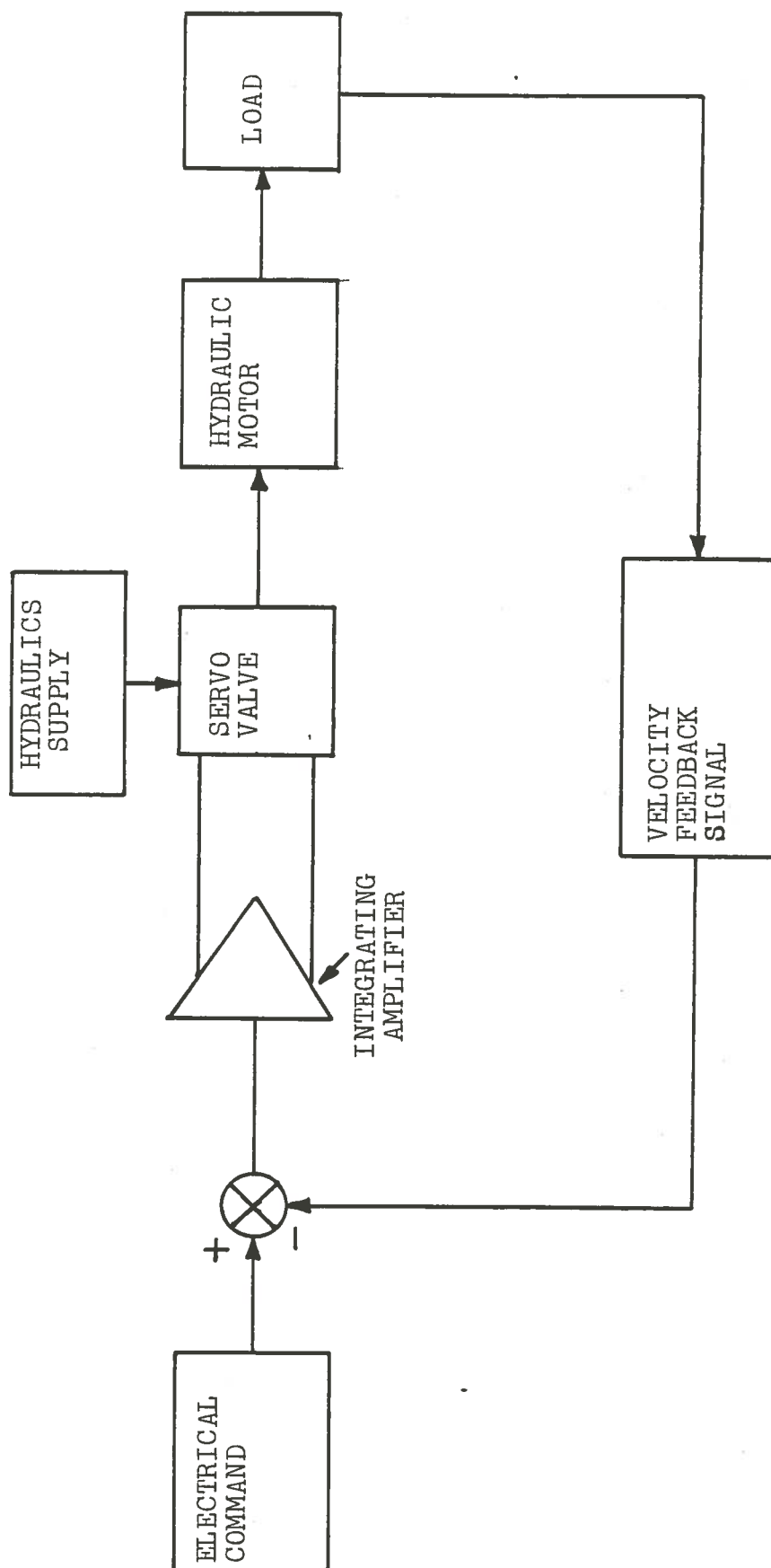


FIGURE 6 - Servo Valve Velocity Control System



923471 — 923494



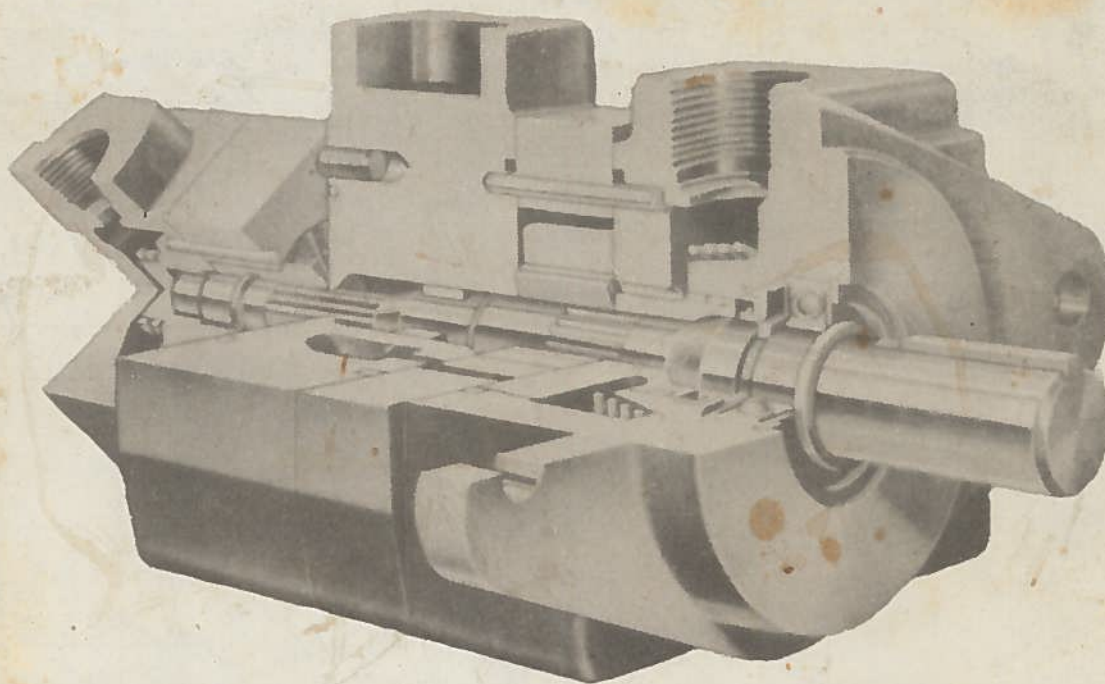
Dup

Service Parts Information

Double Pumps

V2010 and V2010F Series
-10 Design

99



Vickers, Incorporated

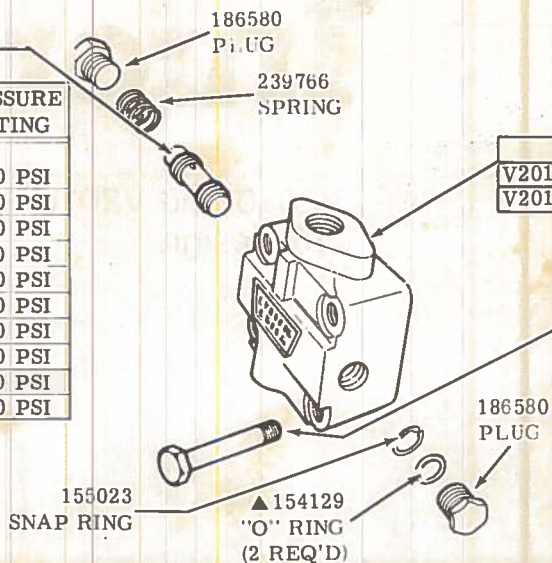
1401 Crooks Road
Troy, Michigan 48084

Revised 12-1-87

M-2253-S

V2010F-*****-20
FLOW CONTROL COVER

MODEL DESIGNATION	CONTROL VALVE SUB-ASSEMBLY	PRESSURE SETTING
V2010F-*****-A	229613	250 PSI
V2010F-*****-B	233018	500 PSI
V2010F-*****-C	232794	750 PSI
V2010F-*****-D	232795	1000 PSI
V2010F-*****-E	232796	1250 PSI
V2010F-*****-F	232797	1500 PSI
V2010F-*****-G	232798	1750 PSI
V2010F-*****-H	232799	2000 PSI
V2010F-*****-J	233019	2250 PSI
V2010F-*****-K	233020	2500 PSI



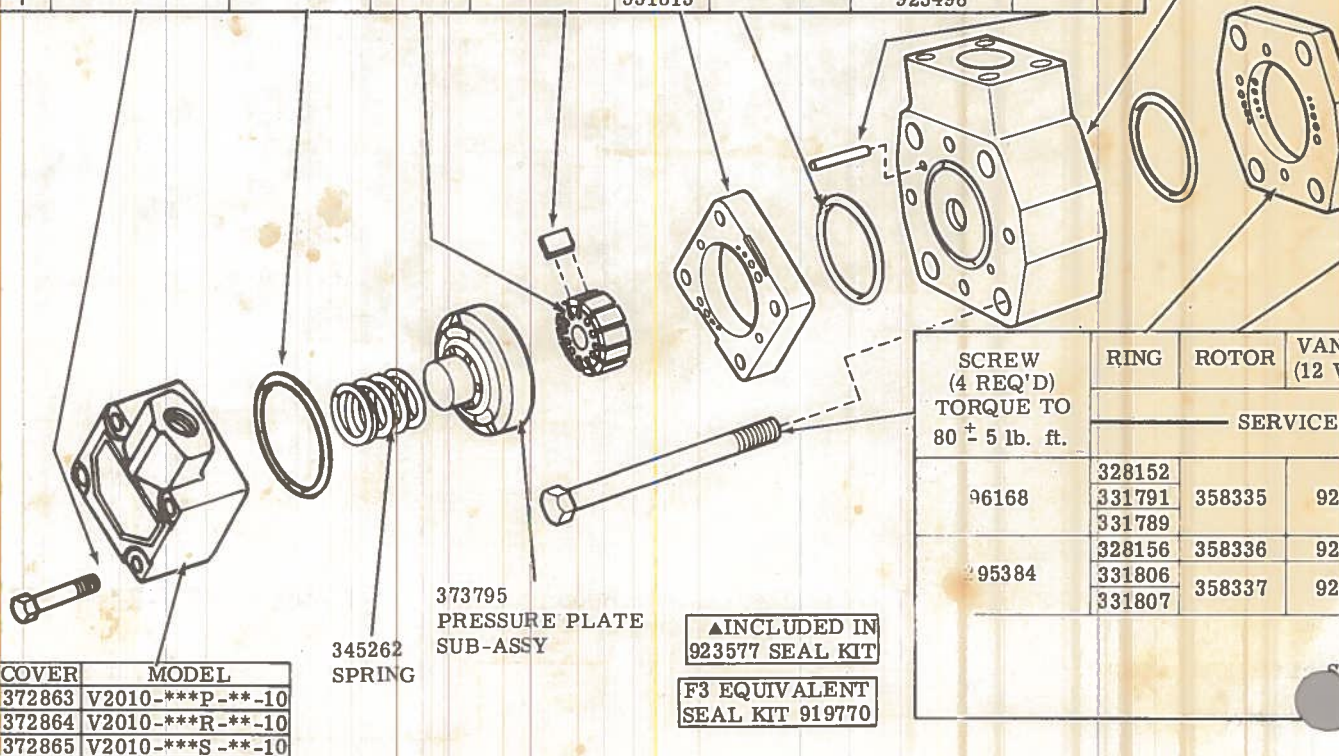
MODEL	COVER
V2010F-*****T-2	372851
V2010F-*****F-2	379543

MODEL DESIGNATION	SCREW (4 REQ'D) TORQUE 40 ± 5 lb. ft.
V2010F-****1	
V2010F-****2	432509
V2010F-****3	
V2010F-****4	295344
V2010F-****5	
V2010F-****6	432511
V2010F-****7	

COVER END - ROTATING GROUP

MODEL DESIGNATION	SCREW (4 REQ'D) TORQUE TO 40 ± 5 lb. ft.	▲"O" RING	ROTOR	VANE KIT (12 VANES)	RING	▲"O" RING	CARTRIDGE KIT	PIN (2 REQ'D)
SERVICED IN CARTRIDGE KIT								
V2010-****1	1277	199822	317681	923499	317674	199823	923471	231042
V2010-****2					317675		923470	
V2010-****3					317676		923496	
V2010-****4	108561	199822	351247	923500	317677	199823	923469	2456
V2010-****5					317678		923468	
V2010-****6					355641		923497	
V2010-****7	1278		357286	923501	331813		923498	351963

MODEL DESIGNATION
V2010-****



COVER	MODEL
372863	V2010-****P-10
372864	V2010-****R-10
372865	V2010-****S-10

▲INCLUDED IN
923577 SEAL KIT
F3 EQUIVALENT
SEAL KIT 919770

SCREW (4 REQ'D) TORQUE TO 80 ± 5 lb. ft.	RING	ROTOR	VAN (12 V)
96168	328152	358335	923471
	331791		
	331789		
95384	328156	358336	923470
	331806		
	331807		

MODEL DESIGNATION	TYPE	RET. RING	BEARING	SHAFT	KEY	NUT	RET. RING
V2010-*****-1**10	STRAIGHT	160686	82938	351249	9955	18755	140356
V2010-*****-3**10	THREADED			321214	1617		
V2010-*****-11**10	SPLINED			321215			

358347
PRESSURE
PLATE

▲ 200142
"O" RING

309795
SPRING

▲ 229236
SHAFT
SEAL

BODY S. A.
AND BUSHING

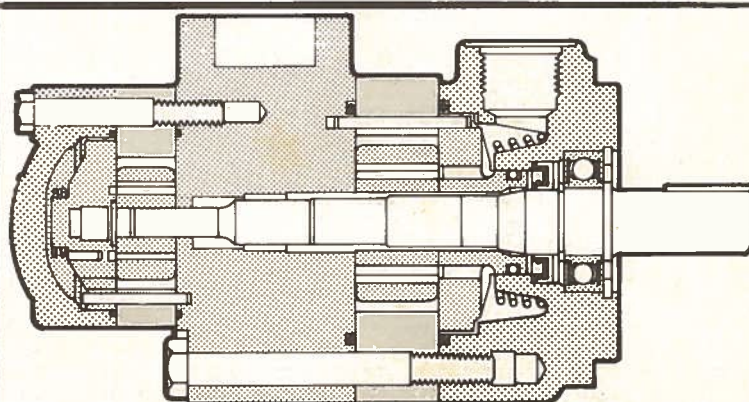
357292

MODEL DESIGNATION	BODY
V2010-***S	315120

WARNING: USE THIS DRAWING FOR PARTS INFORMATION ONLY.

"O" RING (2 REQ'D)	CARTRIDGE KIT	PIN (2 REQ'D)	MODEL DESIGNATION
▲ 154090	923494	16662	V2010-***7**
	923495		V2010-***8**
	923462		V2010-***9**
	923475	179341	V2010-***11**
	923476	7688	V2010-***12**
	923477		V2010-***13**

ROTATING GROUP



ASSEMBLY VIEW

MODEL CODE BREAKDOWN

(F3)-V2010 *-*(*)F*S*S-1**-10(L)

SEALS
F3 - VITON
OMITTED - BUNA N

VANE PUMP

SERIES

F - FLOW CONTROL COVER
P - PRIORITY VALVE COVER

MOUNTING
1 - FLANGE
2 - FOOT
BRACKET

FOOT BRACKET
MOUNTING POSITION WITH
RESPECT TO INLET PORT
WHEN VIEWED FROM SHAFT
END. NO CODE REQUIRED
FOR INLET PORT AT 12
O'CLOCK.
3 - INLET PORT AT 3 O'CLOCK
6 - INLET PORT AT 6 O'CLOCK
9 - INLET PORT AT 9 O'CLOCK
OMITTED FOR FLANGE
MOUNTING

INLET PORT
F - 4 BOLT FLANGE
1.500 DIA.

RING CAPACITY - SHAFT END
(USGPM AT 1200 RPM & 100 PSI)
7 - 7 9 - 9 12 - 12
8 - 8 11 - 11 13 - 13

NO. 1 OUTLET PORT (SHAFT END)
S - 1.062 - 12 UN-2B THREAD

SHAFT ROTATION
L - LEFT HAND
(OMITTED FOR
RIGHT HAND)

DESIGN

OUTLET POSITIONS VIEWED FROM COVER END		
#1 OUTLET	#2 OUTLET	
OPPOSITE INLET	AA	135° CCW FROM INLET
	AB	45° CCW FROM INLET
	AC	45° CW FROM INLET
	AD	135° CW FROM INLET
90° CCW FROM INLET	BA	135° CCW FROM INLET
	BB	45° CCW FROM INLET
	BC	45° CW FROM INLET
	BD	135° CW FROM INLET
INLINE WITH INLET	CA	135° CCW FROM INLET
	CB	45° CCW FROM INLET
	CC	45° CW FROM INLET
	CD	135° CW FROM INLET
90° CW FROM INLET	DA	135° CCW FROM INLET
	DB	45° CCW FROM INLET
	DC	45° CW FROM INLET
	DD	135° CW FROM INLET

SHAFT TYPE
1 - STRAIGHT THD.
3 - THREADED
11 - SPLINED

NO. 2 OUTLET PORT (COVER END)

CODE	STD COVER	FLOW CONTROL COVER	
		PRESSURE	TANK
P	1/2 IN. NPT THD	3/4-16 ST. THD.	1/2 IN NPT THD
R	1.062-12 ST. THD	—	—
S	3/4-16 ST. THD	—	—
T	—	3/4-16 ST. THD.	3/4-16 ST THD

RING CAPACITY - COVER END
(USGPM AT 1200 RPM & 100 PSI)

1 - 1 3 - 3 5 - 5
2 - 2 4 - 4 6 - 6
7 - 7

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

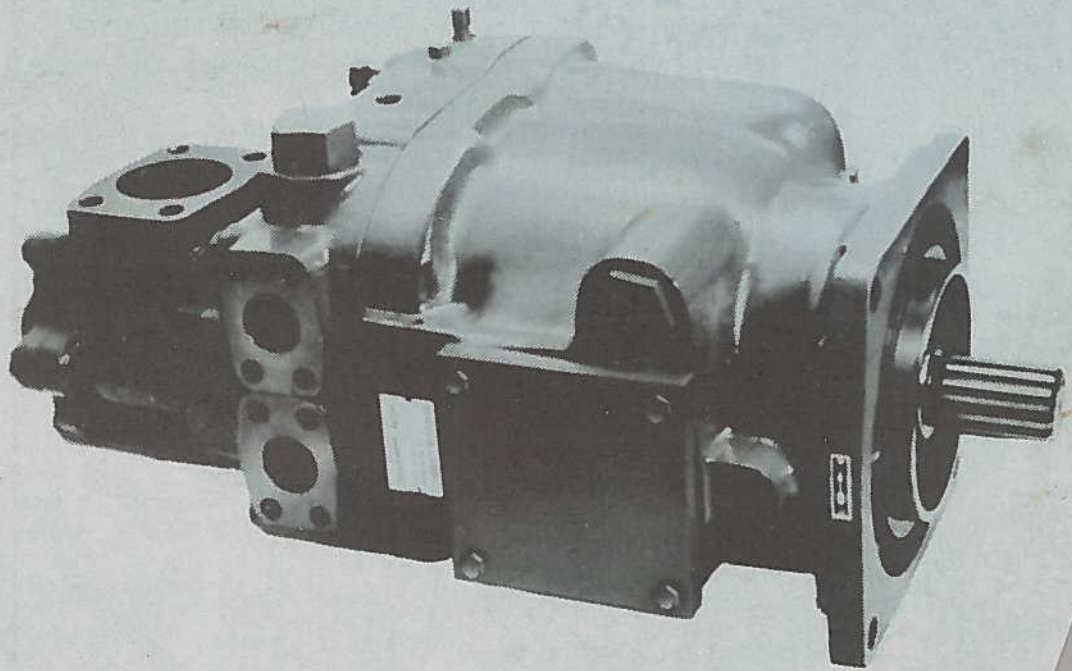
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Service Parts Information

HEAVY DUTY
PISTON PUMP

PVD120C-*--*-12-C**-14

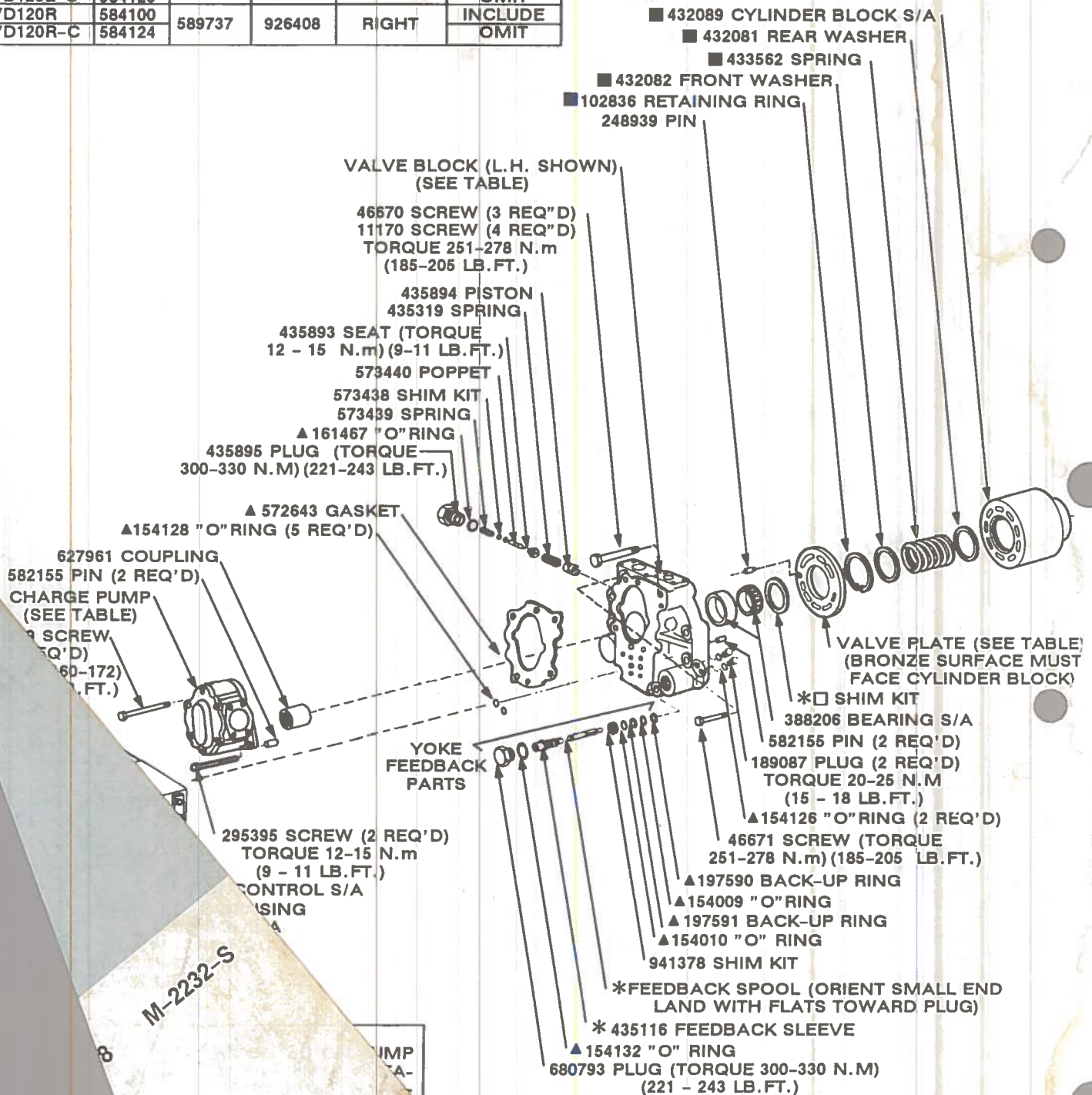


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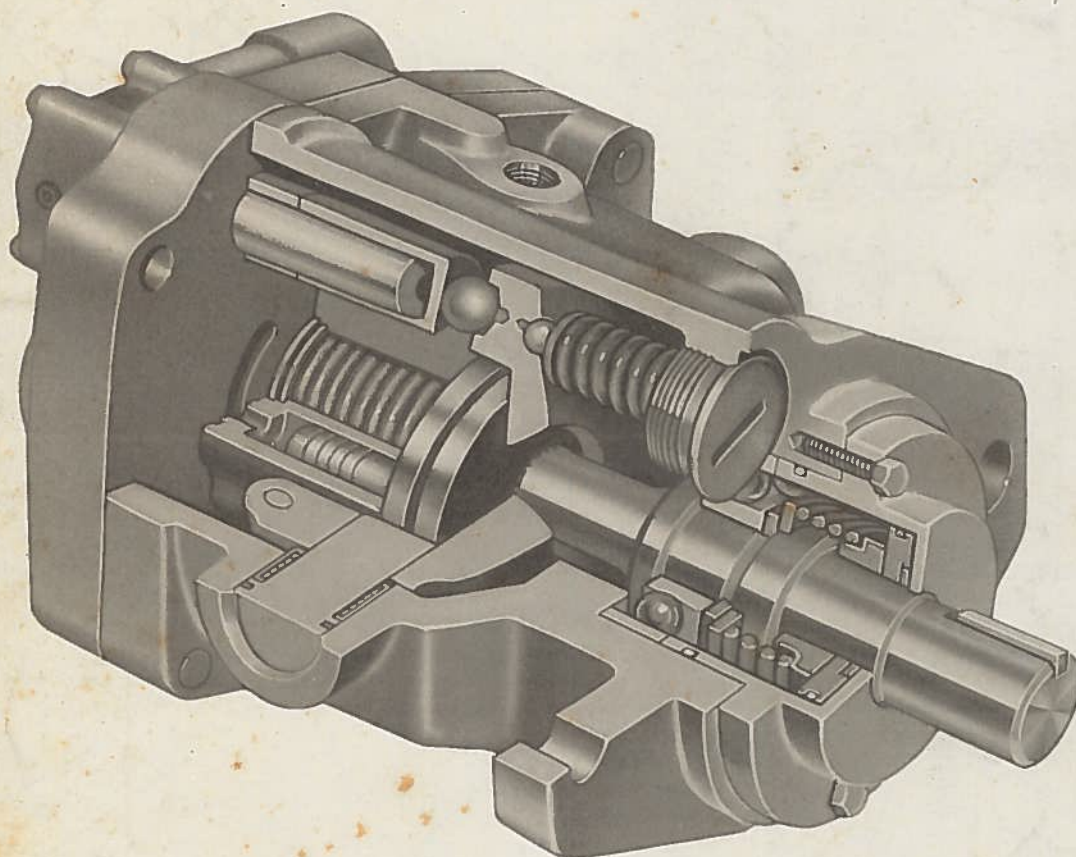
MODEL	VALVE BLOCK	VALVE PLATE	CHARGE PUMP KIT	ROTATION DIRECTION	YOKE FEEDBACK PARTS
PVD120L	581895	589733	926484	LEFT	INCLUDE
PVD120L-C	584125				OMIT
PVD120R	584100	589737	926408	RIGHT	INCLUDE
PVD120R-C	584124				OMIT



Service Parts Information

**Variable
Inline
Piston
Motors**

**M-MVB20 and M-MVB29
-10 Design -032 Feature**



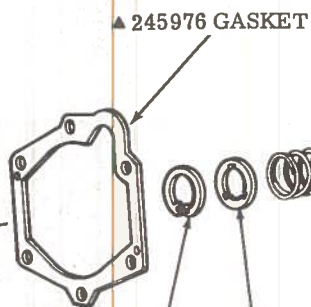
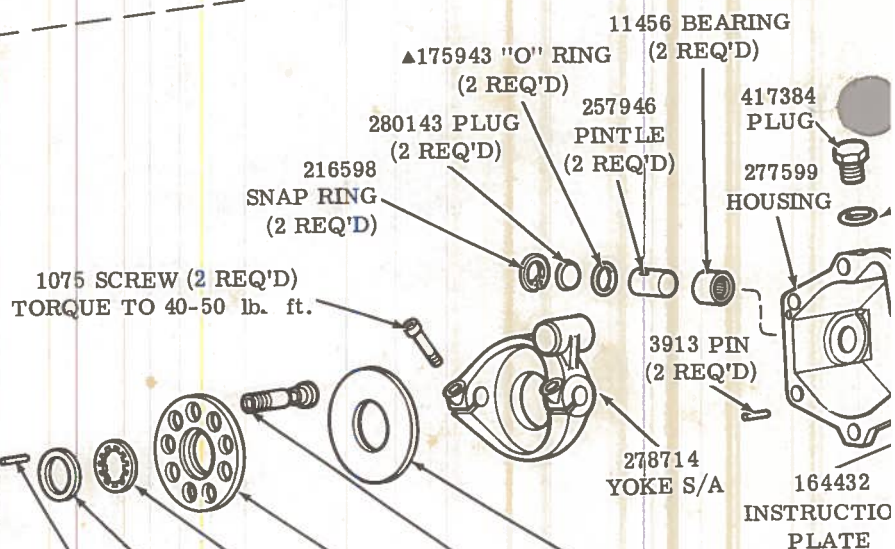
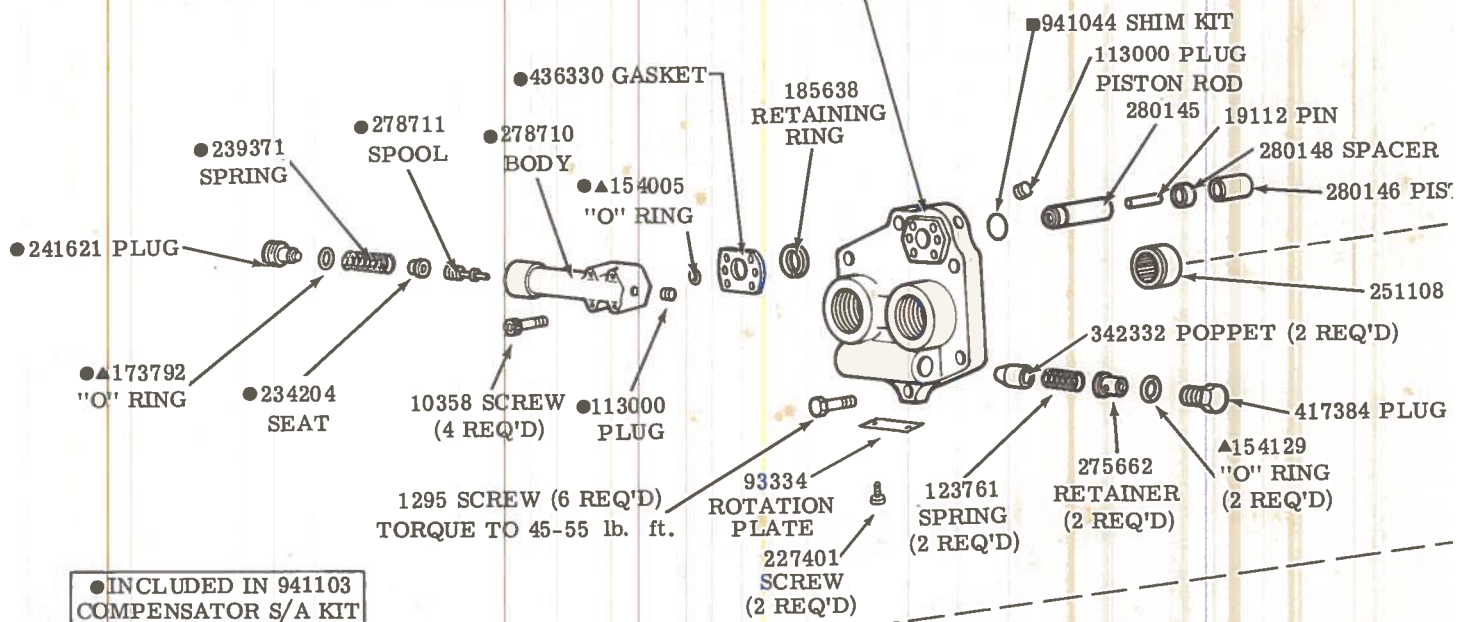
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M-2773-s

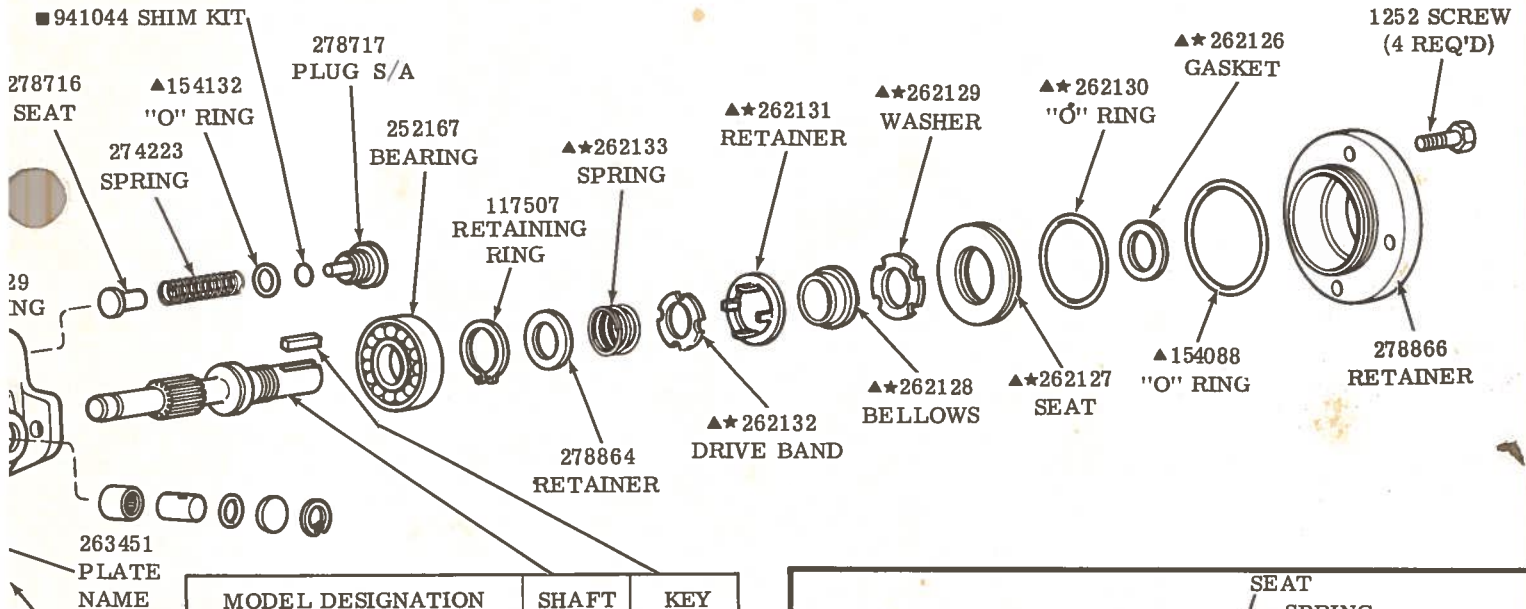
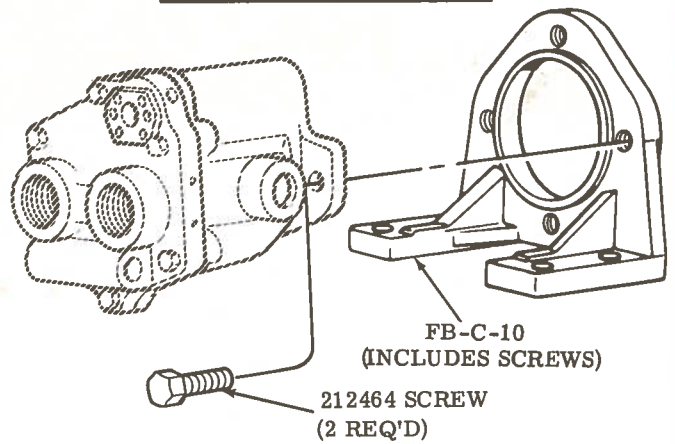
MODEL DESIGNATION	VALVE PLATE SUB-ASSY. INCLUDES 251108 BEARING	VALVE PLATE
M-MVB20-US-10-CL-10-032		275667
M-MVB29-US-10-CR-10-032	923376	
M-MVB29-US-10-CL-10-032	923377	



RET. RING	WASHER	SPRING	THRUST WASHER	CYLINDER BLOCK	PIN (3 REQ'D)	WASHER	SPHERICAL WASHER	SHOE PLATE	PISTON KIT (9 PISTONS)	SWASH PLATE	ROT. GR
THESE PARTS ARE INCLUDED IN ROTATING GROUP											
194025	244931	246387	238780	284197 287454	248835	938392 Sub-Assy.	248609	941884 923326	239335	93	92

■ REFER TO SHIM INSTALLATION
PROCEDURE ON BACK PAGE.

FOOT MOUNTING BRACKET



401 SCREW
4 REQ'D)

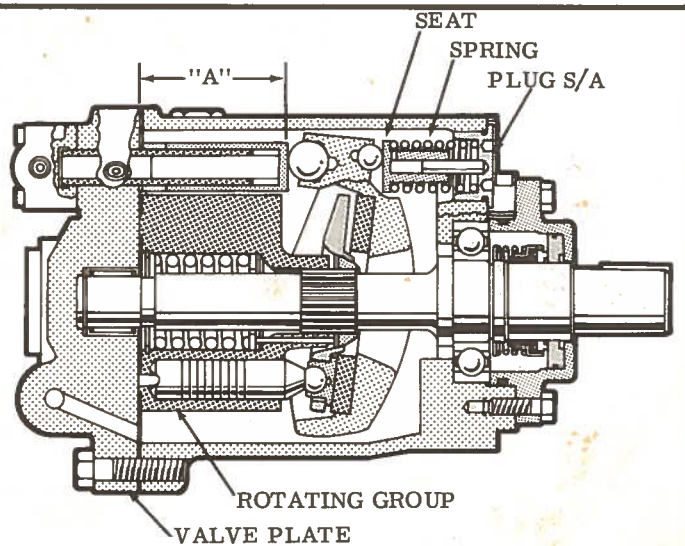
MODEL DESIGNATION	SHAFT	KEY
M-MVB*-**-10-*-10-032	278865	246353
M-MVB*-**G-10-*-10-032	291224	—

MODEL

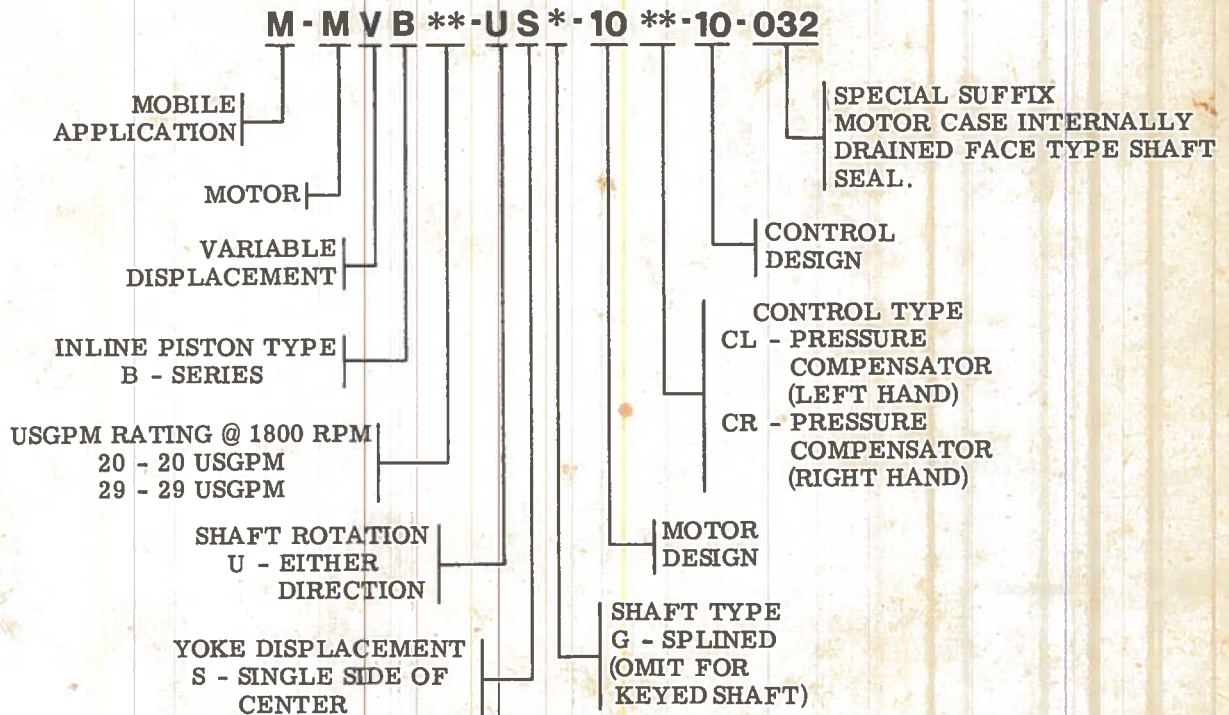
M-MVB20**-10-*-10-032
M-MVB29**-10-*-10-032

★ = SERVICED IN 262125 SEAL ASSEMBLY

▲ = SERVICED IN 922892 SEAL KIT



MODEL CODE BREAKDOWN



SHIM INSTALLATION PROCEDURE

PROCEDURE TO SHIM YOKE FOR MAXIMUM TORQUE (MINIMUM RPM)

1. Remove valve plate, rotating group, and plug S/A. See cross section view.
2. Disassemble the plug S/A, remove shims and spring. Install the seat and plug together (without shims and spring) into the housing.
3. Move the yoke to full stroke position and measure the "A" dimension as shown in cross section view. Subtract 3.347 ± 0.010 inch from the "A" dimension. This is the thickness of shims required. Remove the plug and seat. Install the required shims and recheck the "A" dimension to be 3.347 ± 0.010 inch. Remove the plug S/A again and install the spring. Thread the complete plug S/A into the housing and secure. Install the rotating group back into the housing.

PROCEDURE TO SHIM THE YOKE FOR MAXIMUM RPM (MINIMUM TORQUE)

4. Install balance of shims from the shim kit over the compensator piston rod between the valve plate and compensator piston. Install a new gasket, then install the valve plate with compensator attached against the housing. Thread in the valve plate screws and cross torque each screw to 45-55 lb. ft.

CAUTION

DO NOT allow the motor to exceed 3600 RPM during the following step.

5. Gradually bring up the flow to the motor while checking the RPM. At full flow, the RPM should be less than 3600. Measure the RPM and record. If the recorded RPM is sufficient for your application, the adjustment is completed. If a higher RPM is required, some of the shims must be removed. Tailor the shims to provide the required RPM. DO NOT exceed the 3600 RPM limit with no load.

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 19/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

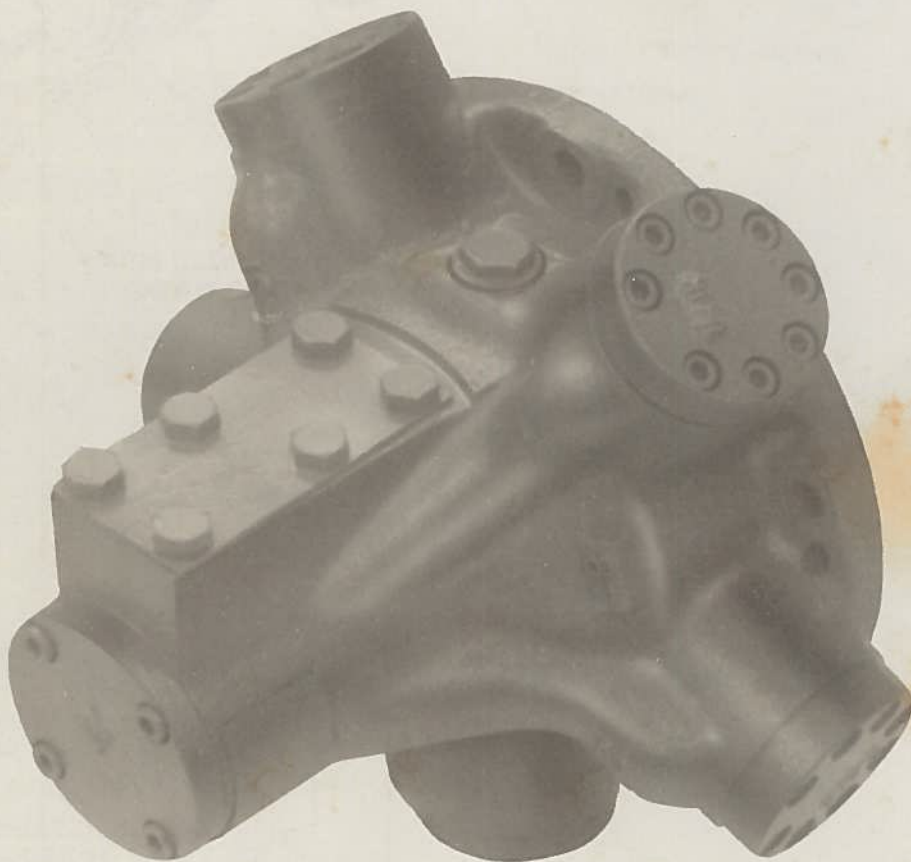
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Service Parts Information

**Staffa
High Torque
Low Speed
Hydraulic Motor**

HMB-010-P-10

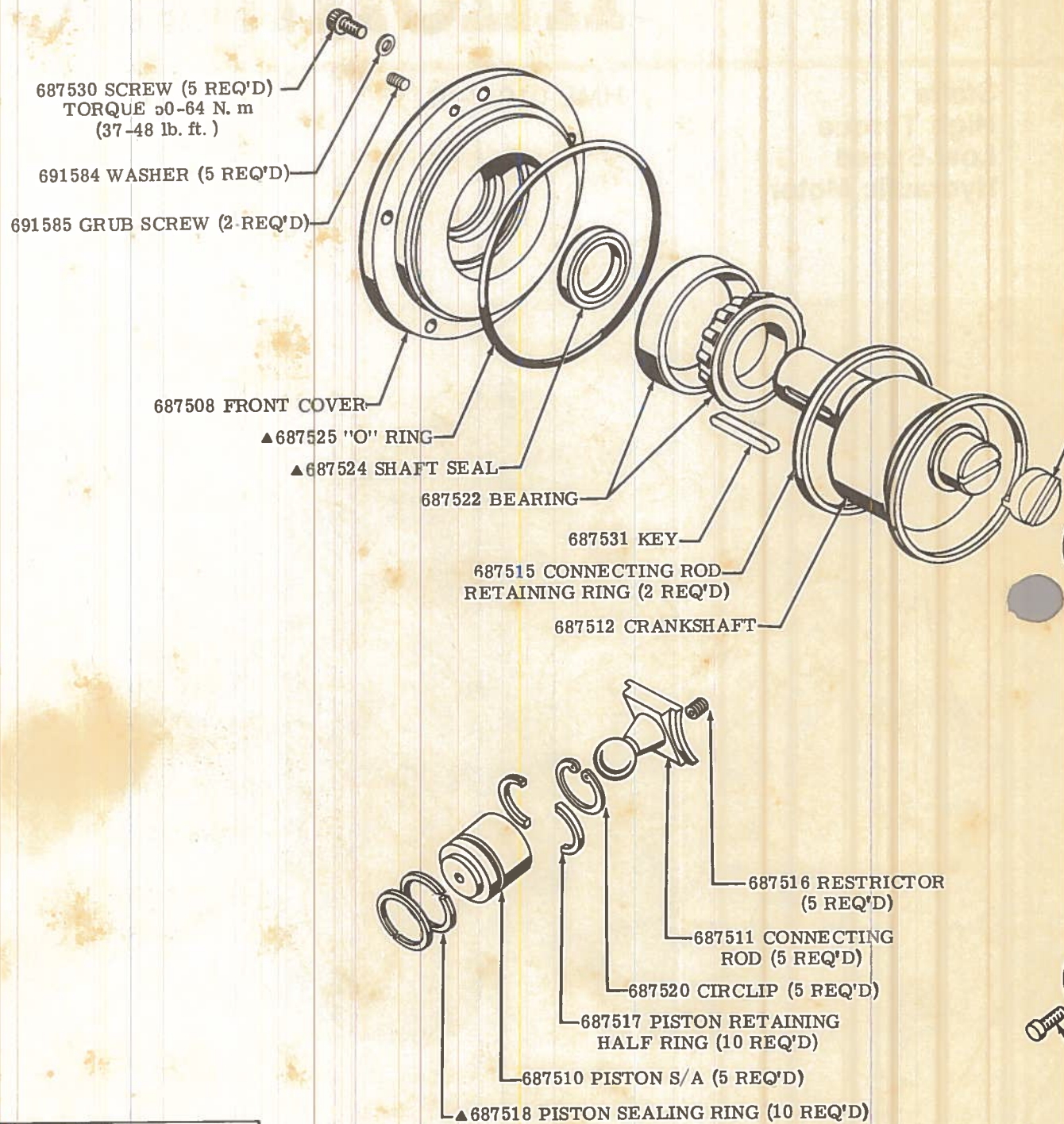


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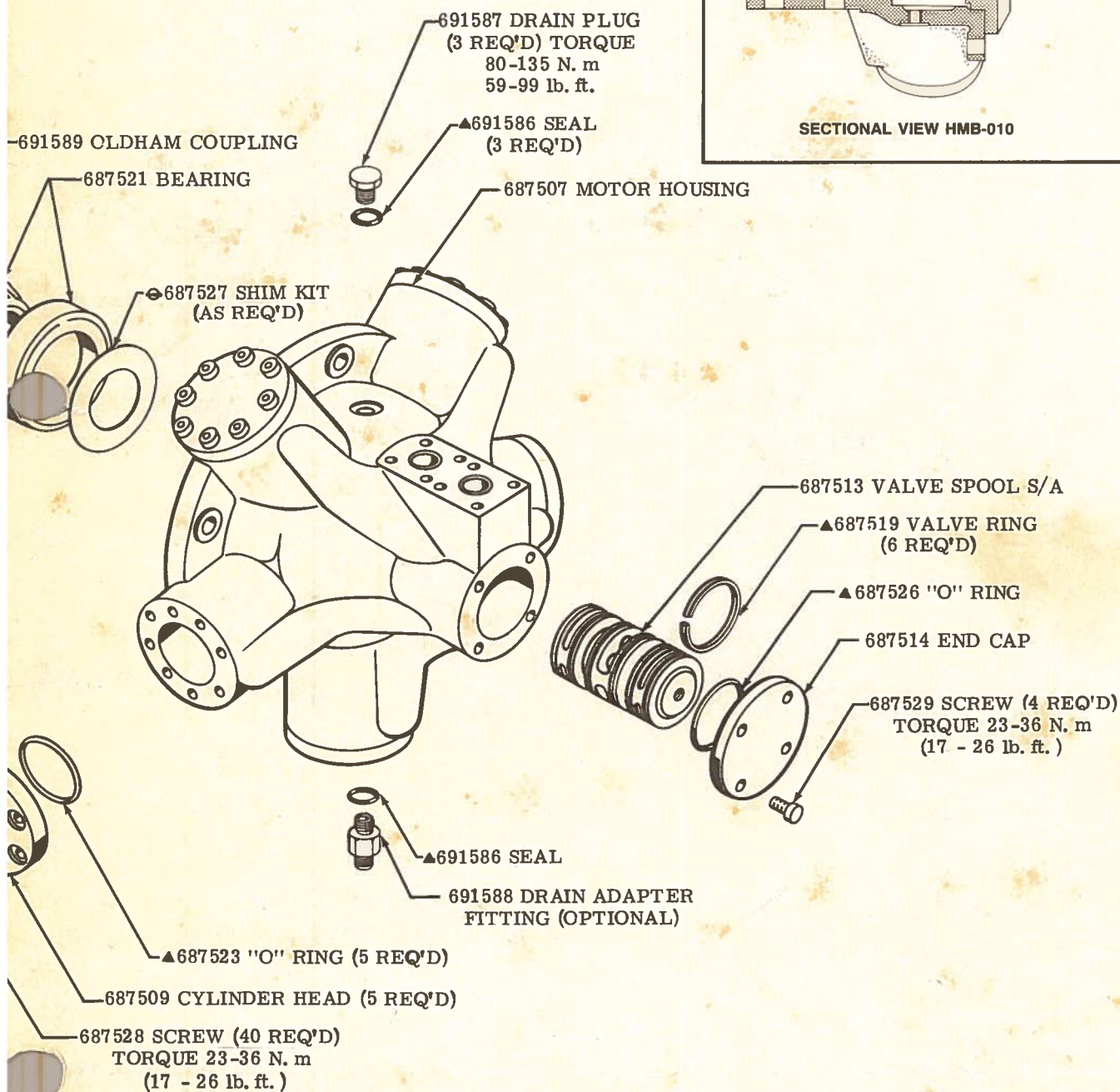
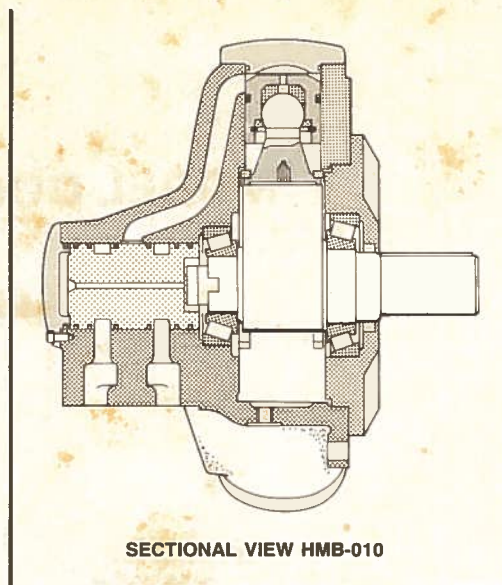
RELEASED 7-1-86

M-2621-S



NOTE
REFER TO MANUAL M-2620-S
FOR SHIMMING PROCEDURE

▲INCLUDED IN
687584 SERVICE KIT



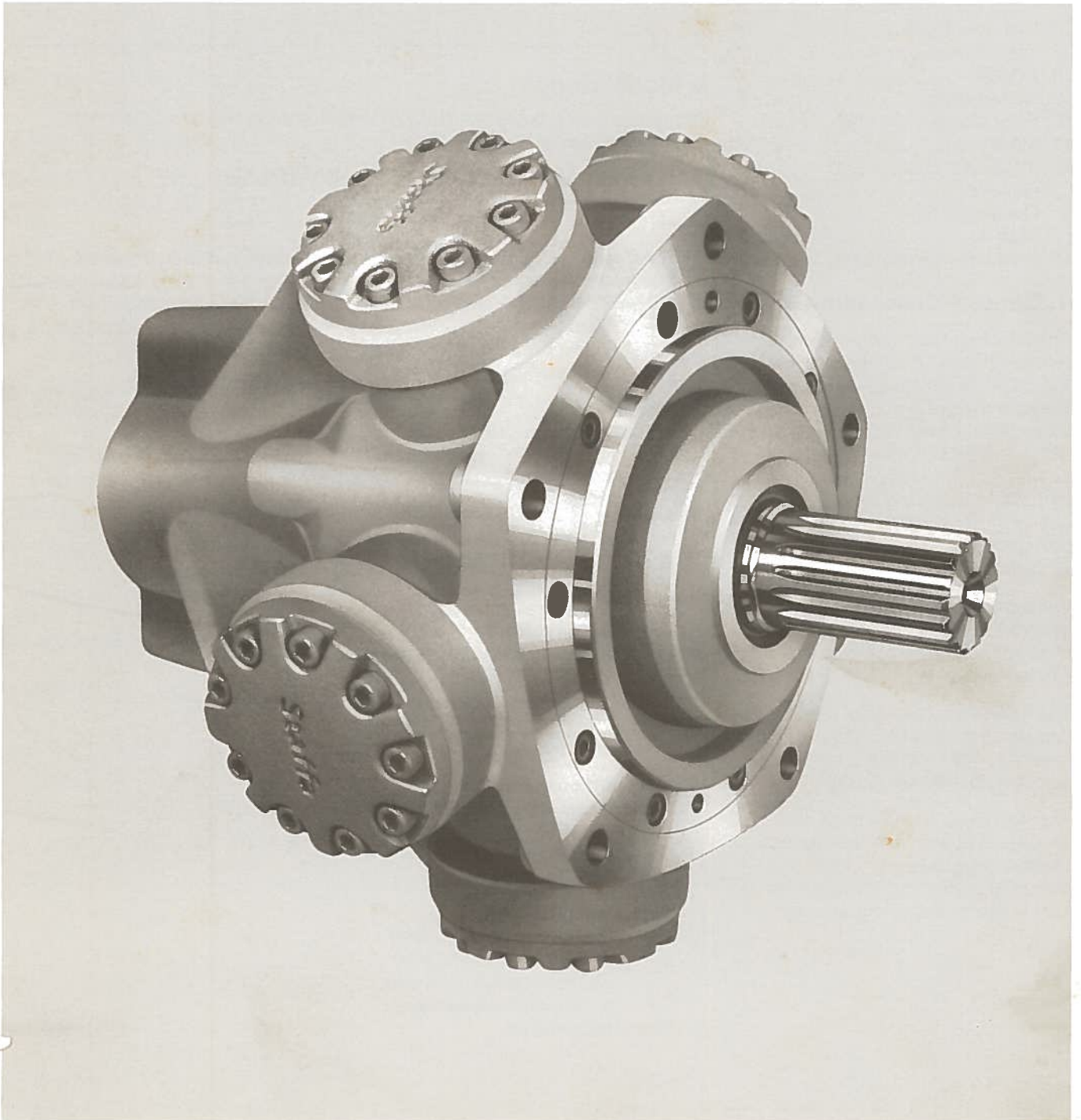
HMB-010-P-10

- HYDRAULIC MOTOR**
- FIXED DISPLACEMENT**
- NOMINAL MOTOR DISPLACEMENT**
in³/Rev.
- DESIGN**
- SHAFT TYPE**
P - PARALLEL KEY

Litho in U. S. A.



Staffa® HMB045 Fixed Displacement Hydraulic Motor



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1. General Description

The HMB045 fixed displacement motor is one of 12 frame sizes in the Kawasaki "Staffa" range of high torque, low speed radial piston motors which extends from 94 to 6800 cm³/r (5.76 to 415 in³/r) capacity. The rugged, well-proven design incorporates hydrostatic balancing techniques to achieve high efficiency, combined with good breakout torque and smooth running capability.

Various features and options are available including, on request, mountings to match competitor interfaces.

The HMB045 is capable of torque outputs up to 3230 Nm (2380 lbf ft) and speeds to 400 r/min with a continuous output of up to 60 kW (80 hp).

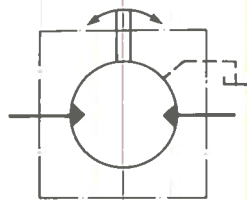
The Kawasaki "Staffa" range also includes dual and continuously variable displacement motors, plus matching brakes and gearboxes to extend the available torque range.

2. Functional Symbols

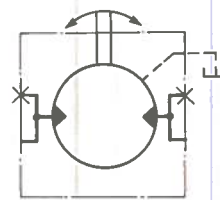
Model types with variants in model code position [4]

HMB045-**-30

(No symbol in model code position [4])



HMB045-**-D-30



3. Model Code

Features shown in brackets () may be left blank according to requirements. All other features must be specified.

(F**) - HM(*)B045 - ** - (*) - (**) - 3* - (PL**)

[1] [2] [3] [4] [5] [6] [7]

[1] Fluid type

Blank = Petroleum oil

F3 = Phosphate ester (HFD fluid)

F11 = Water-based fluids (HFA, HFB & HFC)

[2] Model type

Blank = Standard ("HMB")

M = To NCB (UK) specification 463/1981 ("HMMB")

[3] Shaft type

P* = Cylindrical shaft with key

S* = Cylindrical, 17 splines to BS 3550

Z* = Cylindrical, splines to DIN 5480 (W55 x 3 x 17 x 7h)

Q* = Internally splined shaft to BS 3550; 21 splines

* For installations where shaft is vertically upwards specify "V" after shaft type letter to ensure that additional high level drain port is provided.

[4] Main port connections

Blank = Rear entry ports G1" (BSPF)

D = Dual entry ports G1" (BSPF)

[5] Tacho/encoder drive

T = Staffa original tacho drive

T1 = Suitable for Hohner 3000 series encoders. (Encoder to be ordered separately)

Omit if not required

[6] Design number, 3* series

Subject to change. Installation and performance details remain unaltered for design numbers 30 to 39 inclusive.

[7] Special features

PL**= non-catalogued features, e.g:
Stainless steel shaft sleeves
Alternative encoder and tacho drives

Alternative port connections
Shaft variants
Alternative capacities
Special mountings
Special paint

** Number assigned as required to specific customer build.

4. Performance Data

Performance data is valid for Staffa HMB045 motors fully run in and operating with petroleum oil. See separate table for pressure and speed limits when using fire-resistant fluids. Leakage values are at fluid viscosity of 50 cSt (232 SUS).

Motor Data

Geometric displacement▲	740 cm ³ /r (45 in ³ /r)
Average actual running torque	10,95 Nm/bar (0.557 lbf ft/psi)
Max. continuous ♦ speed	400 r/min
Max. continuous ♦ output	60 kW (80 hp)
Max. continuous ♦ pressure	250 bar (3625 psi)
Max. intermittent ♦ pressure	293 bar (4250 psi)

▲ Other displacements can be made available to special order

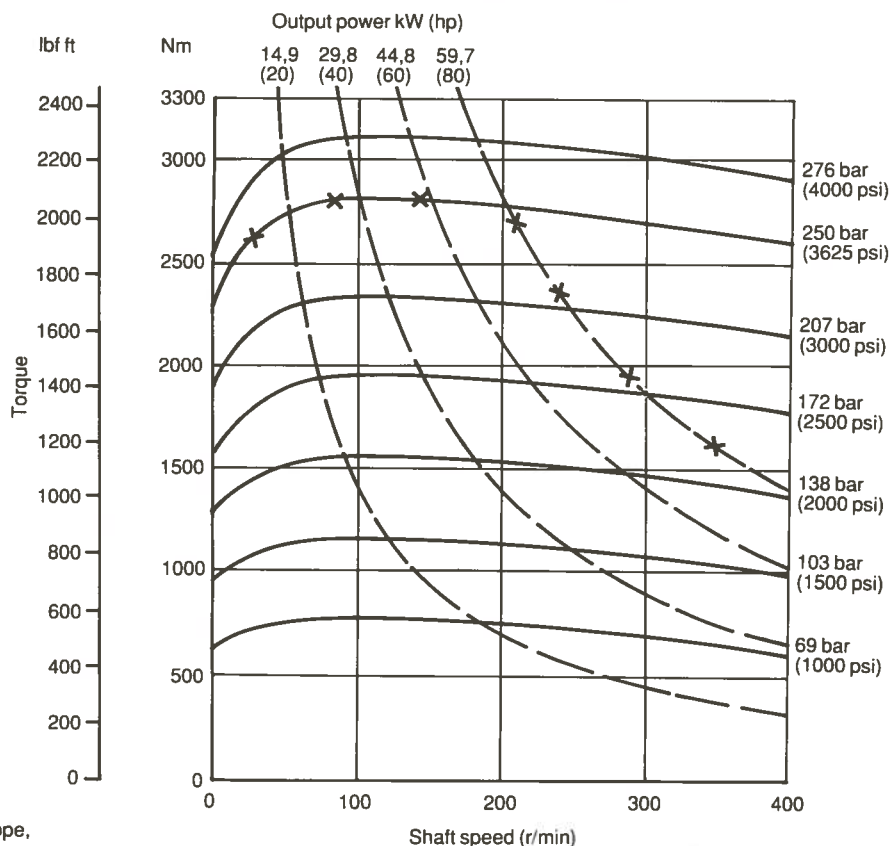
♦ See "Rating Definitions", this page

Limits for Fire Resistant Fluids

Fluid type	Pressure, bar (psi)		Max. speed r/min
	Continuous	Intermittent	
HFA, 5/95% oil-in-water emulsion	103 (1500)	138 (2000)	50% of limits for petroleum oil
HFB, 60/40% water-in-oil emulsion	138 (2000)	172 (2500)	As for petroleum oil
HFC, water glycol	103 (1500)	138 (2000)	50% of limits for petroleum oil
HFD, phosphate ester	250 (3625)	293 (4250)	As for petroleum oil

Output Torques

The torque curves indicate the maximum output torque and power of a fully run-in motor for a range of pressures and speeds when operating with zero outlet pressure on petroleum oil of 50 cSt (232 SUS) viscosity. High return line pressures will reduce torque for a given pressure differential.



—x—x— Upper limit of continuous rating envelope, see "Rating definitions" above

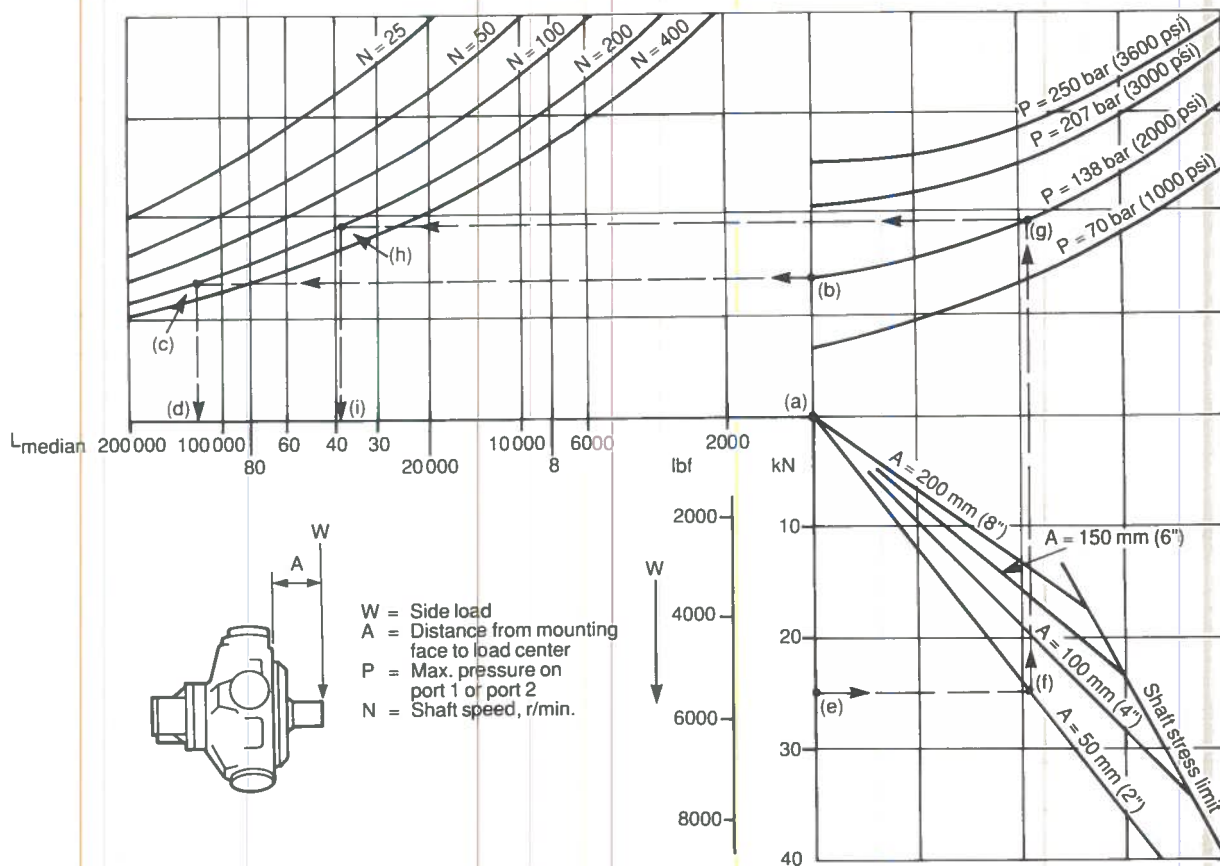
Rating Definitions

• Continuous rating
For continuous duty the motor must be operating within each of the maximum values for speed, pressure and power.

• Intermittent rating
Operation within the intermittent power rating (up to the maximum continuous speed) is permitted on a 15% duty basis, for periods up to 5 minutes maximum.

• Intermittent max. pressure
Up to 293 bar (4250 psi) is allowable on the following basis:

- Up to 50 r/min: 15% duty for periods up to 5 minutes maximum.
- Over 50 r/min: 2% duty for periods up to 30 seconds maximum.



The nomograph allows the median bearing life to be determined for conditions of:

1. No side load and no axial thrust
2. Side load and no axial thrust

▲ To determine L10 life predictions per ISO 281-1-1977 multiply the median figure by 0.2.

Example 1 (follow chain dotted line):

- a) Side load (W) = 0
- b) System pressure (P) = 138 bar (2000 psi)
- c) Speed (N) = 200 r/min
- d) Median bearing life = 115 000 hrs (L10 bearing rating, calculated from (d) = 23 000 hrs)

Example 2 (follow chain dotted line):

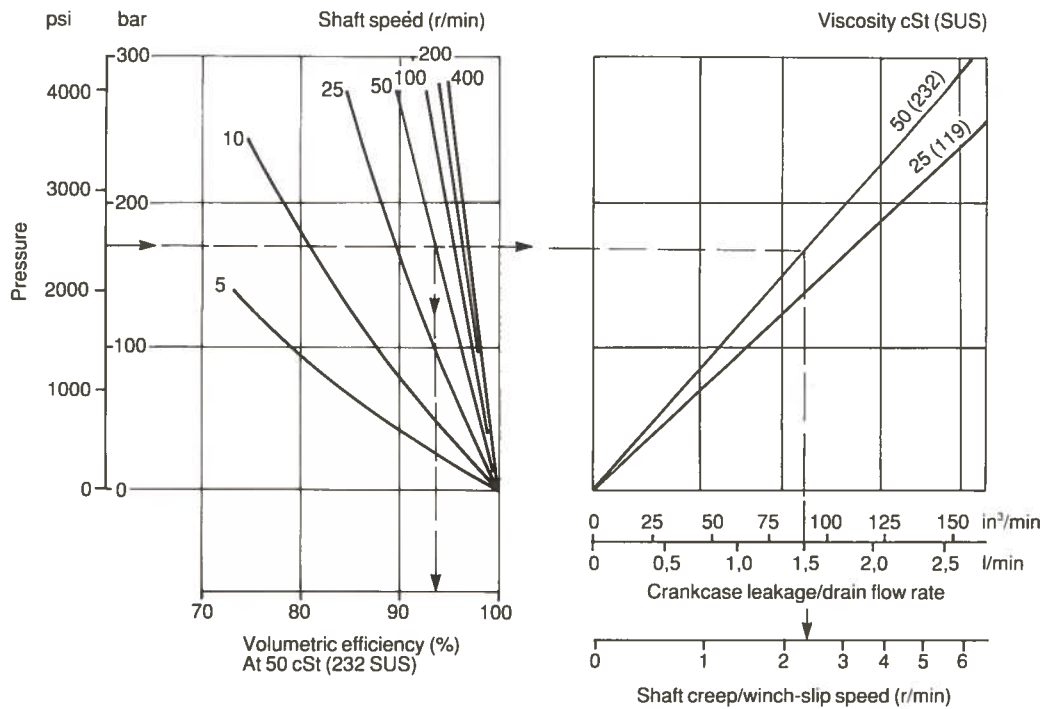
- e) Side load (W) = 25 kN (5600 lbf)
- f) Load offset from mounting face of motor (A) = 50 mm (2.0 in)
- g) System pressure (P) = 138 bar (2000 psi)
- h) Speed (N) = 200 r/min
- i) Median bearing life = 39 000 hrs (L10 bearing rating, calculated from (i) = 7800 hrs)

For more precise life prediction, or where axial thrusts are incurred, a computer analysis can be provided by Kawasaki on receipt of machine duty cycle.

● Shaft stress limit

The shaft stress limit in the nomograph is based on the fatigue rating of shaft types "S" and "P". Infrequent loading above these limits may be permitted; consult Kawasaki.

Volumetric Efficiency



This nomograph enables the average volumetric efficiency, crankcase (drain) leakage and "winch slip"/shaft creep speed to be estimated.

Example (follow chain dotted line):

Given:

1. Pressure 170 bar (2500 psi)
2. Speed 50 r/min
3. Viscosity 50 cSt (232 SUS)

To obtain:

4. Volumetric efficiency 93.6%
5. Crankcase leakage 1.5 l/min
(90 in^3/min)
6. Shaft creep speed 2.3 r/min

The shaft creep speed occurs when the load attempts to rotate the motor against closed ports as may occur, for example, in winch applications.

5. Circuit and Application Notes

Starting Torques

The starting torques shown on the graph on page 3 are average and will vary with system parameters.

Low Speed Operation

Minimum operating speeds are determined by load conditions (load inertia, drive elasticity, etc.). For operation at speeds below 6 r/min consult Kawasaki.

High Back Pressure

When both inlet and outlet ports are pressurized continuously, the lower pressure in one port must not exceed 70 bar (1000 psi). Consult Kawasaki on applications beyond this limit. Note that high back pressures reduce the effective torque output of the motor.

Boost Pressure

When operating as a motor the outlet pressure should equal or exceed the crankcase pressure. If pumping occurs (i.e. overrunning loads) then a positive pressure, "P", is required at the motor inlet ports. Calculate "P" from:

$$P \text{ (bar)} = 1 + \frac{N^2}{23200} + C \text{ bar}$$

$$P \text{ (psi)} = 14.5 + \frac{N^2}{1600} + C \text{ psi}$$

Where:

N = speed, r/min

C = crankcase pressure

The flow rate of oil needed for the make-up system can be estimated from the crankcase leakage figure (see Volumetric Efficiency graph on page 5). Allowance should be made for other system losses and also for "fair wear and tear" during the life of the motor, pump and other system components.

Cooling Flow

Operation within the continuous ratings does not require any additional cooling.

For operating conditions above "continuous", up to the "intermittent" ratings, additional cooling oil may be required. This can be introduced through the spare crankcase drain hole, or in special cases through the valve spool end cap. Consult Kawasaki about such applications.

Motor Casing Pressure

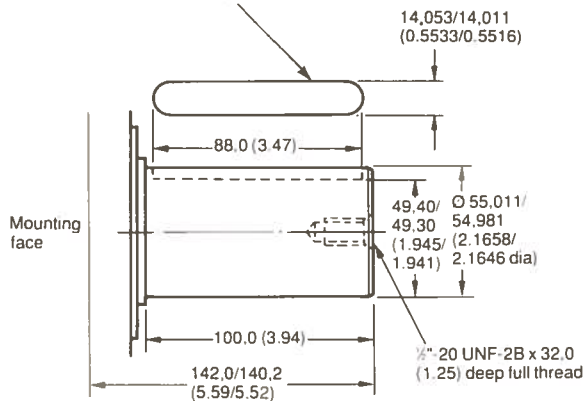
With the standard shaft seal fitted, the motor casing pressure should not exceed 3,5 bar (50 psi). On installations with long drain lines a relief valve is recommended to prevent over-pressurizing the seal.

Notes:

1. The casing pressure at all times must not exceed either the motor inlet or outlet pressure.
2. High pressure shaft seals are available to special order for casing pressures of:
Continuous: 10 bar (150 psi)
Intermittent: 15 bar (225 psi)
3. Check installation dimensions (page 8) for maximum crankcase drain fitting depth.

Shaft type "P", model code position 3

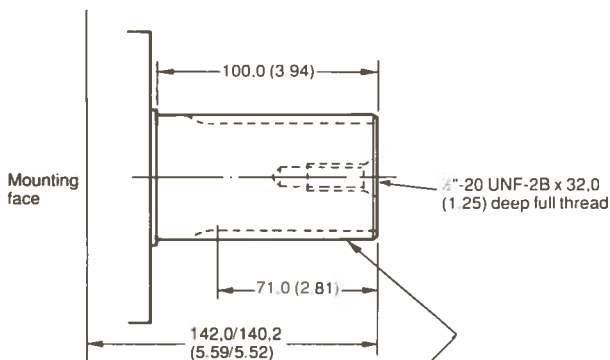
Cylindrical shaft with key

Key (supplied) 14,046/14,028 (0.5530/0.5523) wide x
9.037/8.961 (0.3558/0.3528) thick**Shaft type "S", model code position 3**

Cylindrical shaft with 17 splines to BS 3550-1963

Shaft type "Z", model code position 3

Cylindrical shaft to DIN 5480

**Spline data****For shaft type "S"**

To BS 3550-1963 and ASA B5.15-1960

Flat root side fit, class 1

Pressure angle	30°
Number of teeth	17
Pitch	8/16
Major diameter	56,41/56,28 (2.221/2.216)
Form diameter	50,703 (1.9962)
Minor diameter	50,07/49,60 (1.971/1.953)
Pin diameter	6,096 (0.2400)
Diameter over pins	62,985/62,931 (2.4797/2.4776)

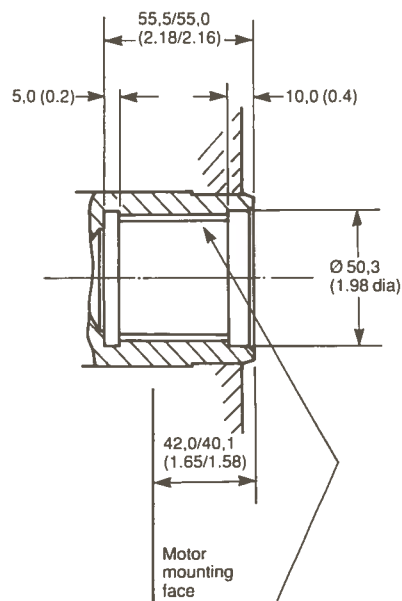
For shaft type "Z"

DIN 5480, W55 x 3 x 17 x 7h

Shaft type "Q", model code position 3

Internally splined to BS 3550; 21 splines

Note: The type "Q" shaft will transmit the maximum torques given on page 3. However, customers should ensure that their own mating shaft will transmit the torque required in their application.

**Spline data**

Internal spline to BS 3550-1963

Flat root, side fit	30°
Pressure angle	21
Number of teeth	12/24
Pitch	46,566/46,896 (1.8333/1.8463)
Major diameter	42,334/42,461 (1.6667/1.6717)
Minor diameter	3,658 (0.1440)
Pin diameter	3,556 (0.1400)
Pin flattened to	39,169/39,103 (1.5421/1.5395)
Diameter between pins	

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VICKERS

Service Parts Information

**Staffa
High Torque
Low Speed
Hydraulic Motor**

HMB-045-*(D)-10

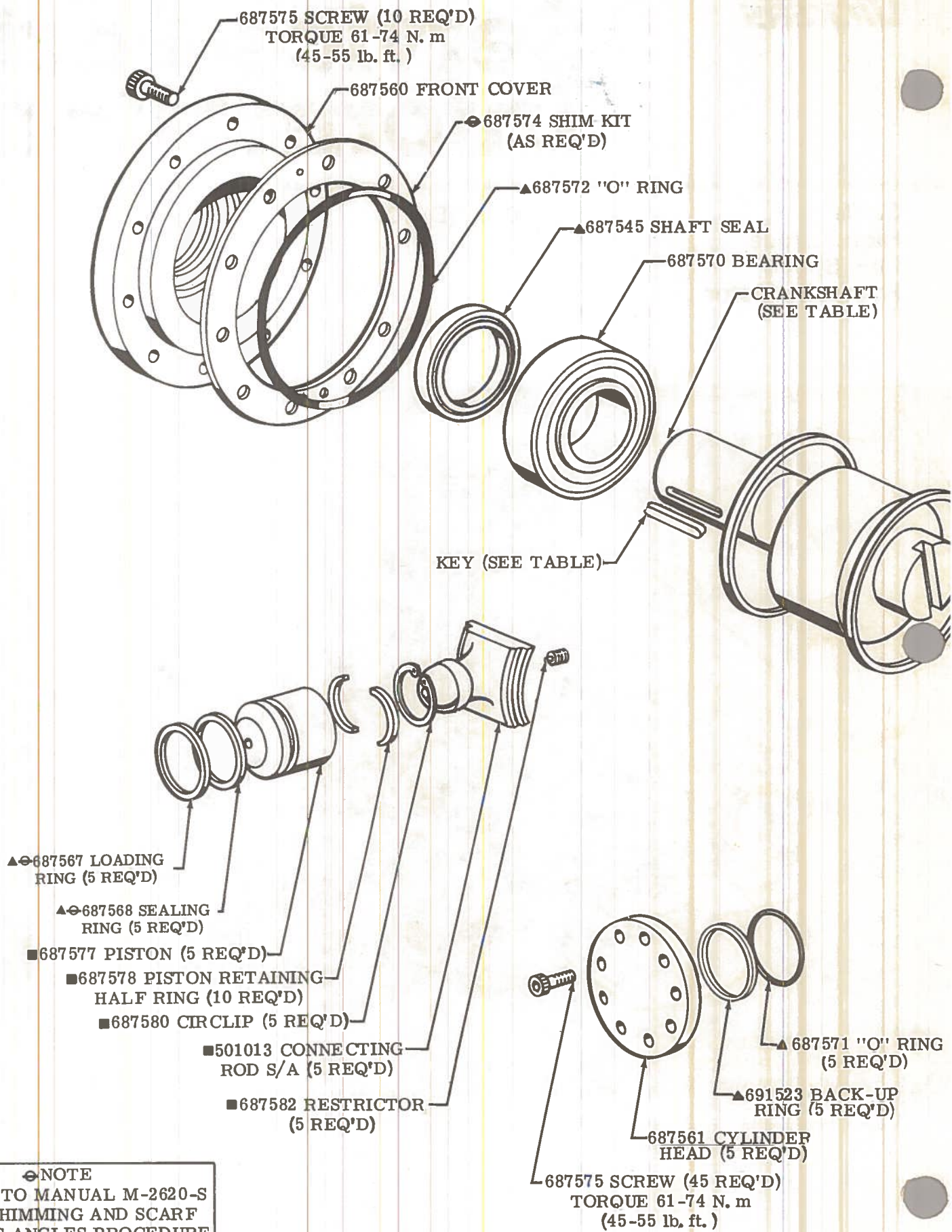


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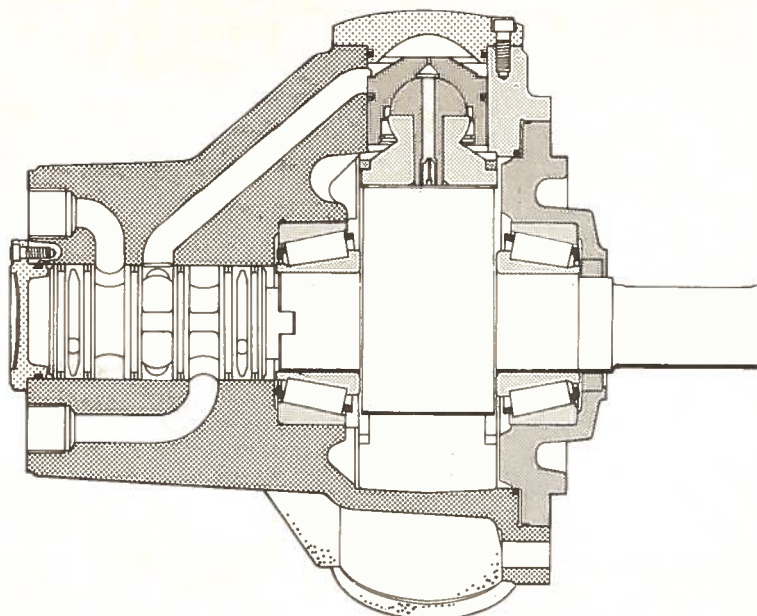
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M-2623-S



▲ INCLUDED IN SEAL KIT 687588
■ INCLUDED IN PISTON KIT 691559
(FOR ONE CYLINDER BORE)

KEY	CRANKSHAFT
687551	687562 PARALLEL
687552	687563 SPLINED



SECTIONAL VIEW HMB-045

VALVE RING INSTALLATION
INSTALL CHAMFER ON EACH
RING NEXT TO WALL OF
GROOVE AS SHOWN



687566 CONNECTING ROD
RETAINING RING (2 REQ'D)

687539 OLDDHAM COUPLING

687570 BEARING

MOTOR HOUSING
(DUAL ENTRY SHOWN)
(SEE TABLE)

MOTOR HOUSING
687559 REAR ENTRY
691560 DUAL ENTRY

977622 DRAIN
CONNECTION
PLUG

▲501176 SEAL
(2 REQ'D)

501177 PLUG
(2 REQ'D)

687564 VALVE SPOOL

▲687569 VALVE RING
(12 REQ'D)

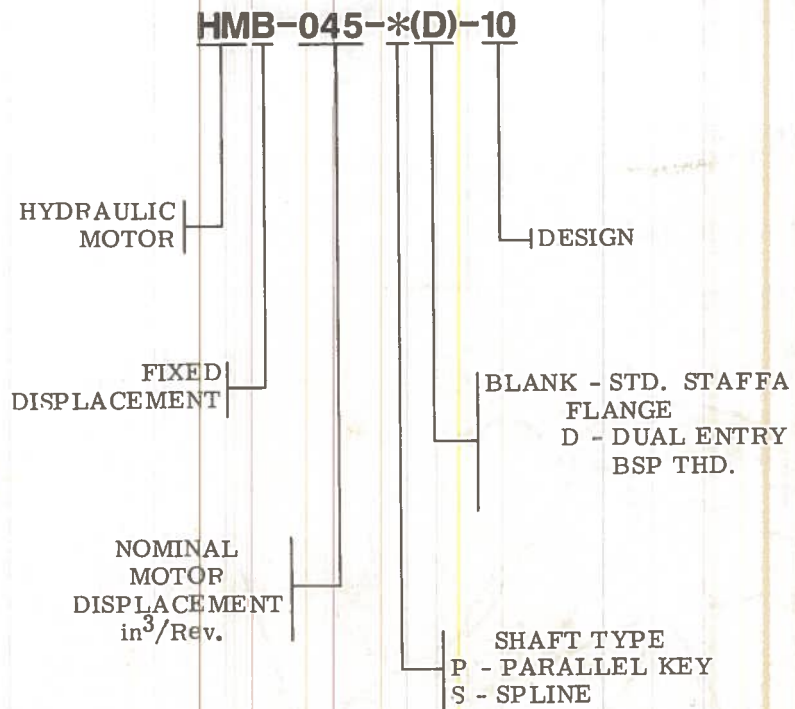
▲687573 "O" RING

687565 END CAP

687576 SCREW (4 REQ'D)
TORQUE 14.9-20.3 N. m
(11-15 lb. ft.)

NAMEPLATE

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

Litho in U. S. A.

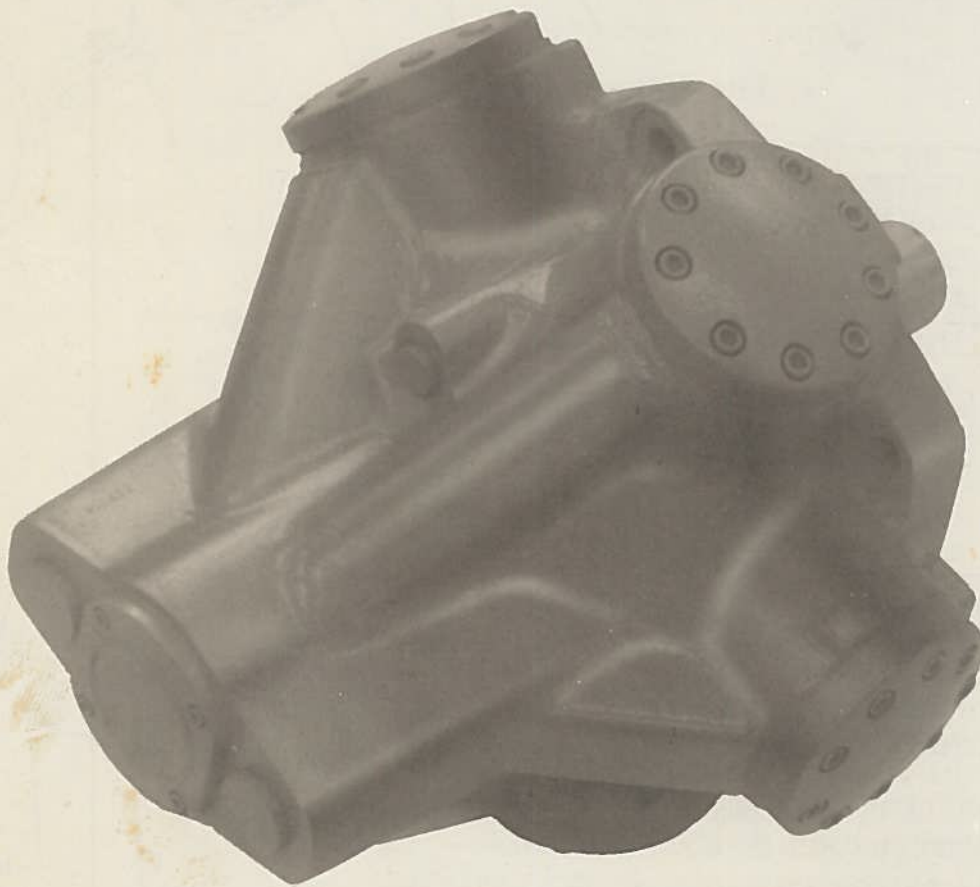
VICKERS

Service Parts Information

**Staffa
High Torque
Low Speed
Hydraulic Motor**

HMB-030-* -10/11

2



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

RELEASED 7-1-86

M-2622-S

687548 SCREW (5 REQ'D)
TORQUE 61-74 N. m
(45-55 lb. ft.)

MODEL	CRANKSHAFT	KEY
PARALLEL	687535	687551
SPLINE	687536	—

687533 FRONT
COVER

691522 SHIM KIT
(AS REQ'D)

▲687546 "O" RING

▲687545 SHAFT SEAL

687543 BEARING

KEY (SEE TABLE)

PART NAME	-10	-11
RESTRICTOR SCREW	687558	687610
CONNECTING ROD	501012	501142
CIRCLIP	687557	687557
PISTON RETAINING HALF RING	687554	501143
PISTON	687552	687552

▲687555 LOADING
RING (5 REQ'D)

▲687556 SEALING
RING (5 REQ'D)

○PISTON (5 REQ'D) (SEE TABLE)

○PISTON RETAINING HALF RING
(10 REQ'D) (SEE TABLE)

○CIRCLIP (5 REQ'D) (SEE TABLE)

○CONNECTING ROD (5 REQ'D) (SEE TABLE)

○RESTRICTOR SCREW (5 REQ'D) (SEE TABLE)

NOTE
REFER TO MANUAL M-2620-S
FOR SCARF CUTTING
ANGLES PROCEDURE

▲INCLUDED IN SEAL KIT 687586
■INCLUDED IN -10 PISTON KIT 691517
(FOR ONE CYLINDER BORE)
○INCLUDED IN -11 PISTON KIT 501144
(FOR ONE CYLINDER BORE)

▲687544 "O"
(5 REQ'D)
▲691516 BACK-I
RING (5 REQ'D)
687534 CYLINDER
HEAD (5 REQ'D)
687548 SCREW (35 REQ'D)
TORQUE 61-74 N. m
(45-55 lb. ft.)

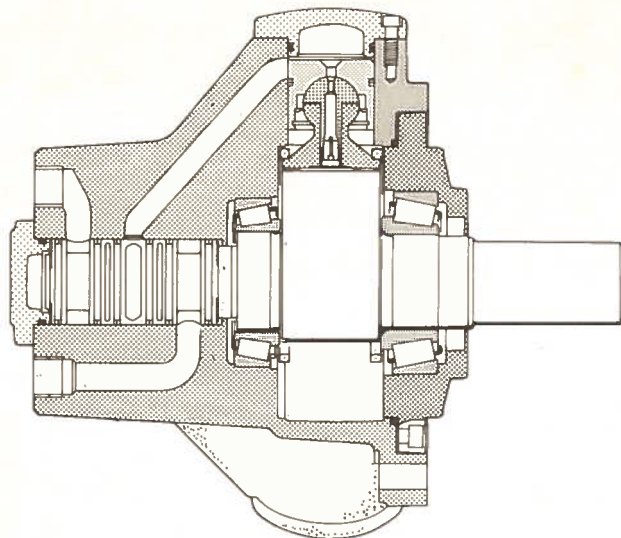
-687540 CONNECTING ROD
RETAINING RING (2 REQ'D)

CRANKSHAFT (SEE TABLE)

687539 OLDHAM COUPLING

687542 BEARING

687532 MOTOR HOUSING



SECTIONAL VIEW HMB-030

VALVE RING INSTALLATION
INSTALL CHAMFER ON EACH
RING NEXT TO WALL OF
GROOVE AS SHOWN



977622 DRAIN
CONNECTION
PLUG

977624 PORT CONNECTION
PLUG (2 REQ'D)

687549 SCREW (4 REQ'D)
TORQUE 14.9-20.3 N. m
(11-15 lb. ft.)

▲ 687541 VALVE RING
(12 REQ'D)

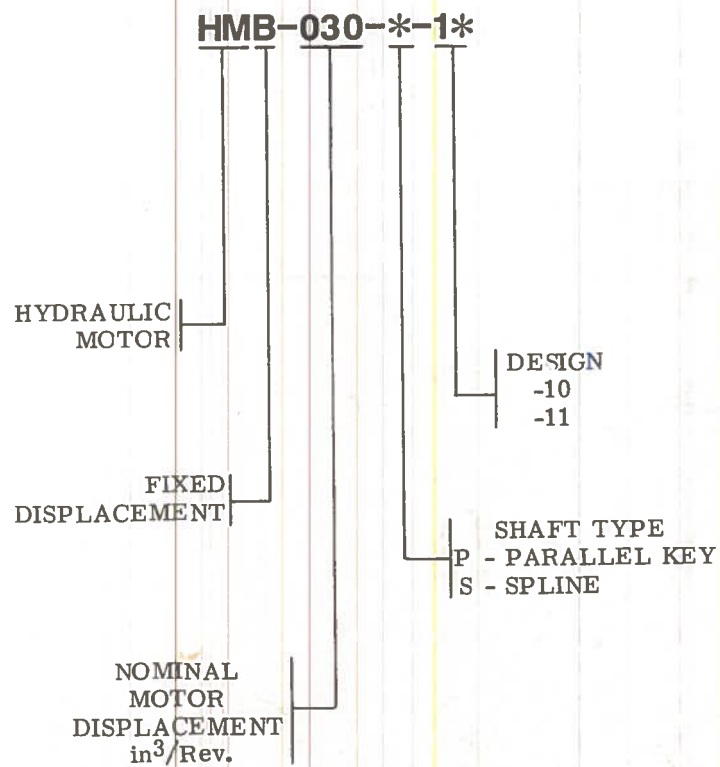
687537 VALVE SPOOL

▲ 687544 "O" RING

687538 END CAP

NAMEPLATE

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

Litho in U. S. A.

**VANE
MOTORS**

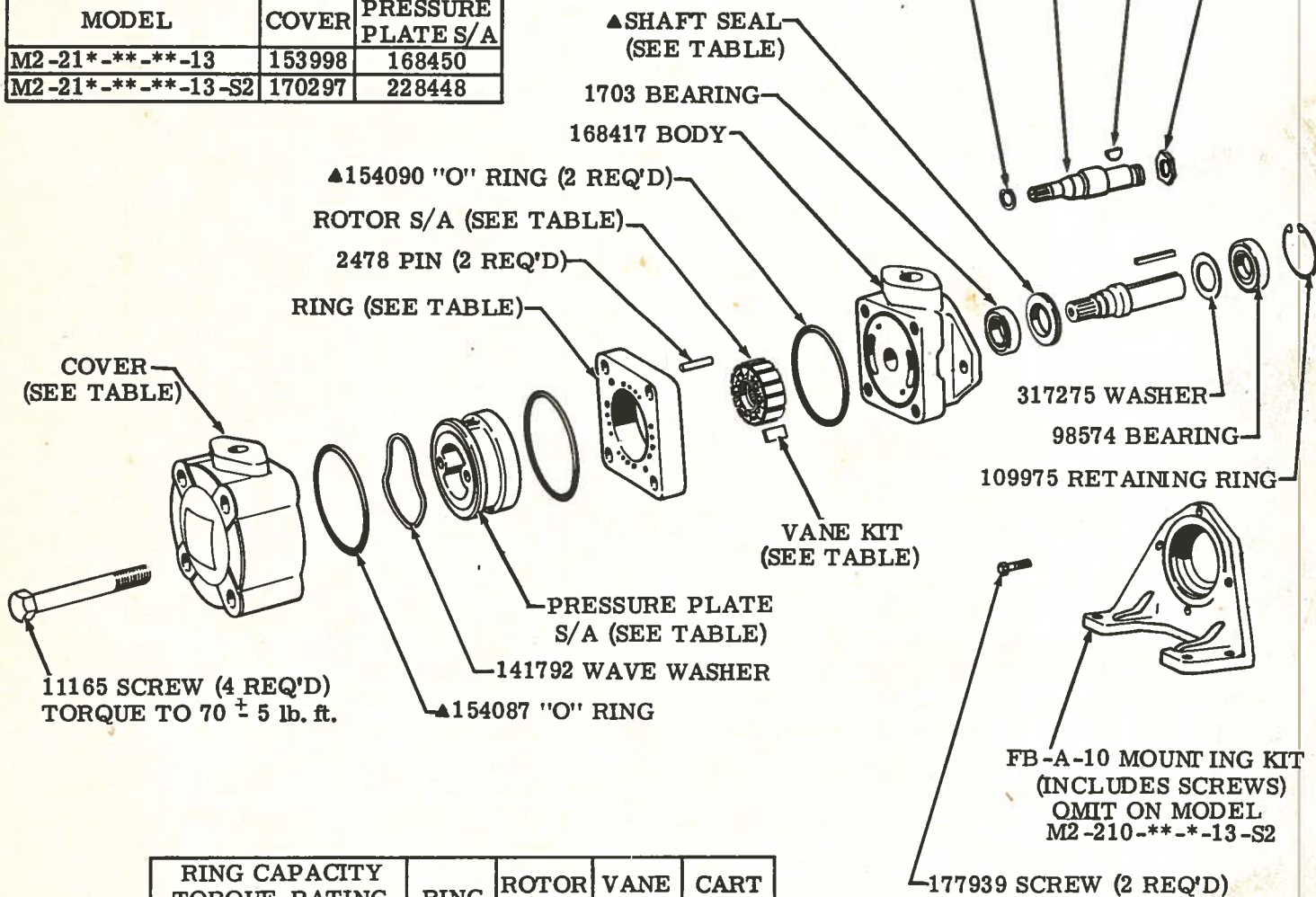
Service Parts Information

M2-200 Series

▲INCLUDED
IN SEAL KIT

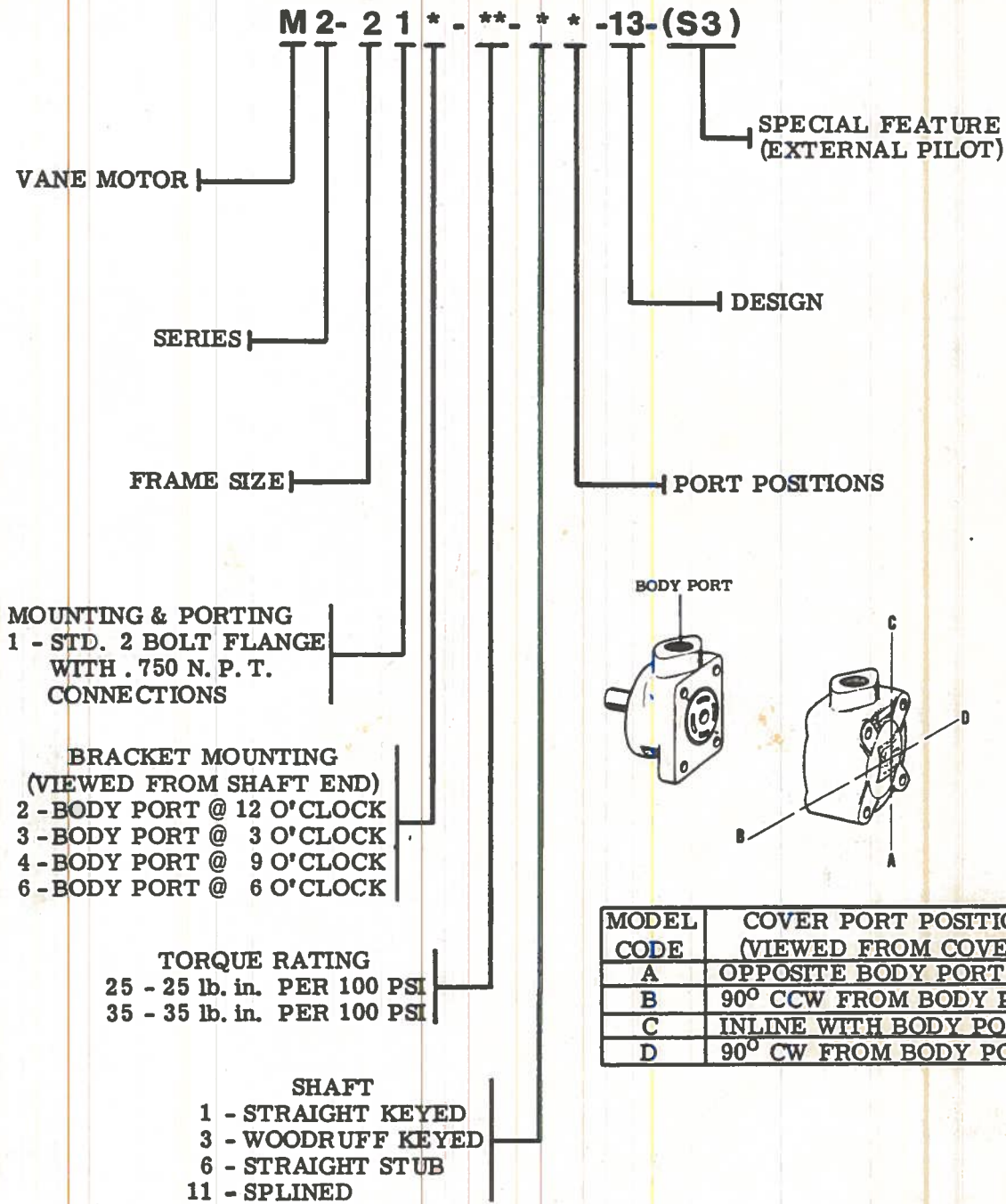
MODEL	COVER	PRESSURE PLATE S/A
M2-21*-**-13	153998	168450
M2-21*-**-13-S2	170297	228448

▲SEAL KIT	▲SHAFT SEAL	SHAFT TYPE	RET. RING	SHAFT	KEY	NUT
922832	229236	M2-21*-**- 1*-13	—	116844	5881	—
922833	229235	M2-21*-**- 3*-13	98653	120037	1615	132260
922832	229236	M2-21*-**- 6*-13	—	131420	1609	—
		M2-21*-**- 9*-13	—	128300	—	—
		M2-21*-**-11*-13	—	133178	—	—



RING CAPACITY TORQUE RATING (lb. in./100 PSI)	RING	ROTOR S/A	VANE KIT	CART KIT
M2-21*-25*-13	168419	168439	912073	922834
M2-21*-25*-13-S2		172294		941203
M2-21*-35*-13	168418	168439		922835
M2-21*-35*-13-S2		172294		941204

MODEL CODE BREAKDOWN



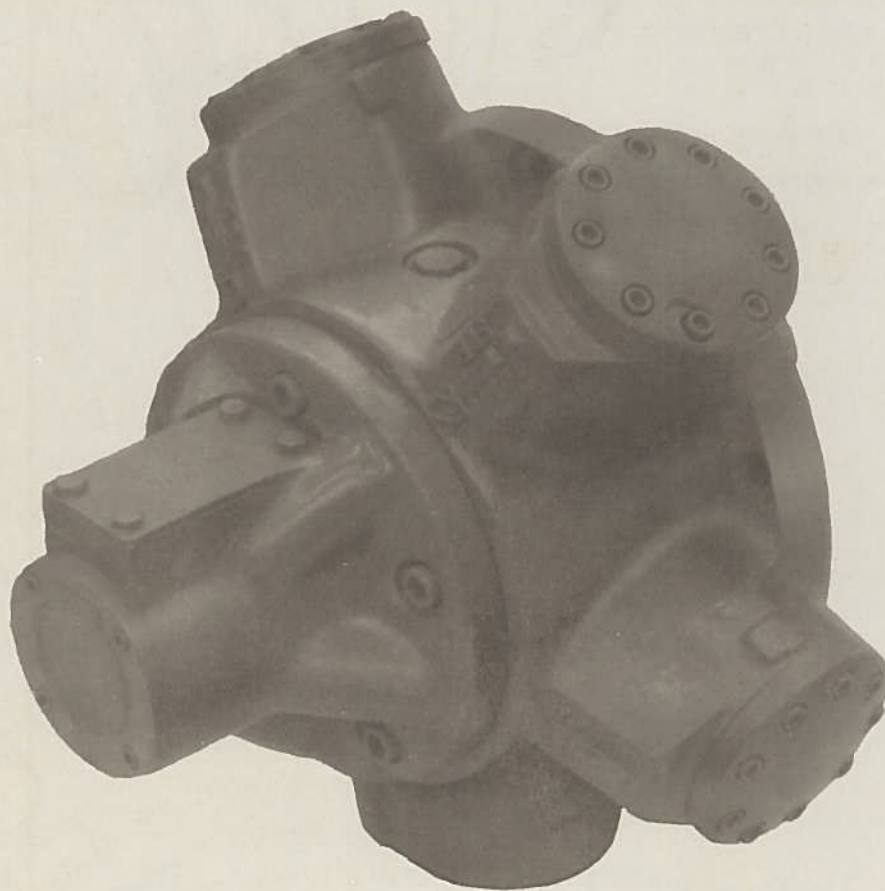
For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

VICKERS

Service Parts Information

Staffa
High Torque
Low Speed
Hydraulic Motor

HMB-060-*(R)-(F)-10



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

RELEASED 7-1-86

M-2624-S

687575 SCREW (10 REQ'D)
TORQUE 61-74 N. m
(45-55 lb. ft.)

687590 FRONT COVER

687593 PLASTIC SHIM KIT

687594 STEEL SHIM KIT

687595 "O" RING

687545 SHAFT SEAL

687591 BEARING

KEY (SEE TABLE)

CRANKSHAFT (SEE TABLE)

687610 RESTRICTOR PLUG (5 REQ'D)

691540 CONNECTING ROD (5 REQ'D)

687612 CIRCLIP (5 REQ'D)

687611 PISTON RETAINING
HALF RING (10 REQ'D)

687608 PISTON (5 REQ'D)

687568 SEALING RING (5 REQ'D)

687567 LOADING RING (5 REQ'D)

687571 "O" RING (5 REQ'D)

691523 BACK-UP RING (5 REQ'D)

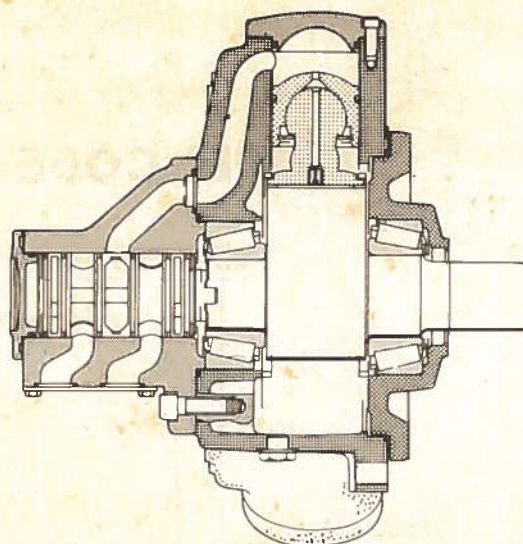
687561 CYLINDER HEAD (5 REQ'D)

687575 SCREW (45 REQ'D)
TORQUE 61-74 N. m (45-55 lb. ft.)

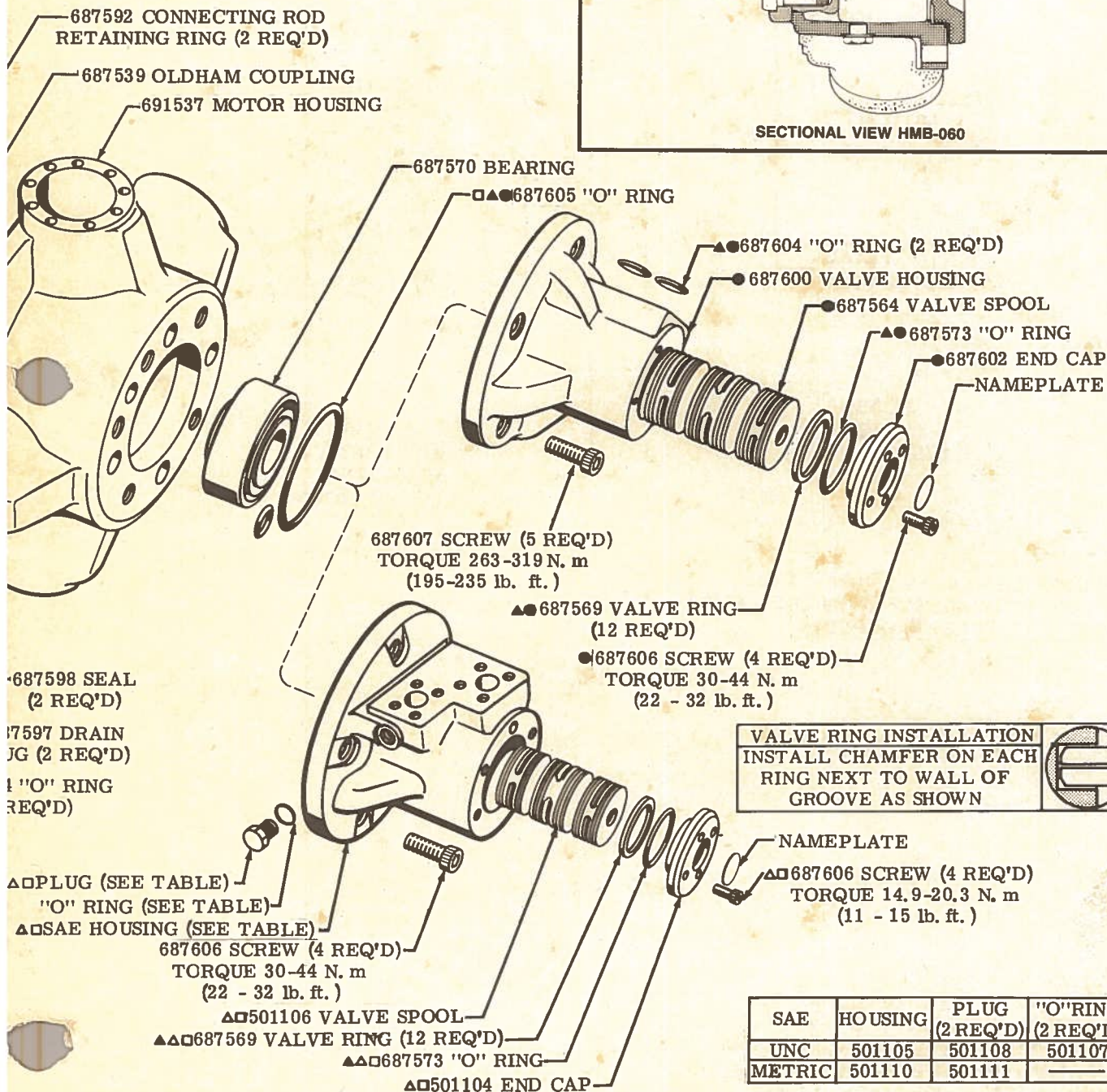
NOTE
REFER TO MANUAL M-2620-S
FOR SHIMMING AND SCARF
CUTTING ANGLES PROCEDURE

- ▲ INCLUDED IN SEAL KIT 687758
- INCLUDED IN PISTON KIT 691543
(FOR ONE CYLINDER BORE)
- INCLUDED IN STD VALVE KIT 687599
- INCLUDED IN SAE (F) VALVE KIT 501109
- ▲ INCLUDED IN SAE (FM) VALVE KIT 501112

KEY	CRANKSHAFT
691542	691538 PARALLEL
—	691539 SPLINED

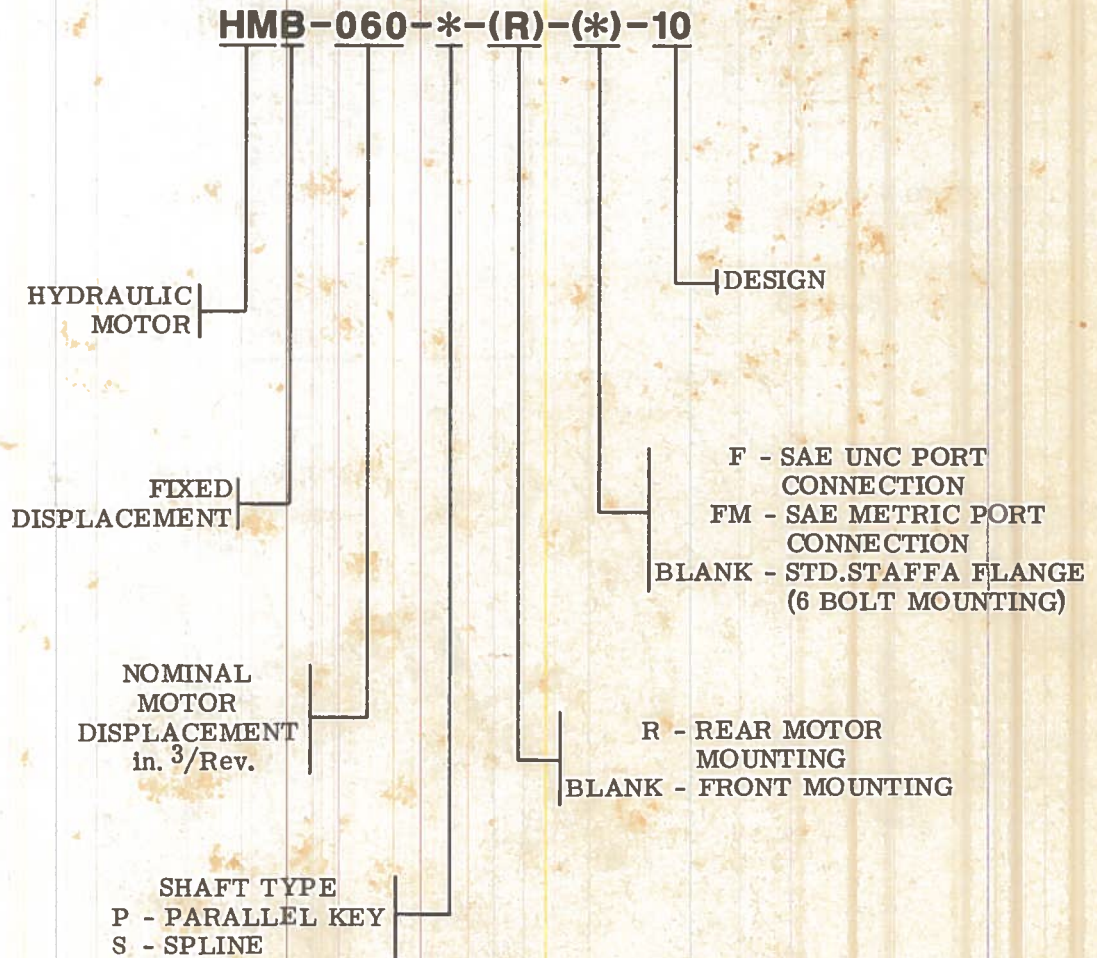


SECTIONAL VIEW HMB-060



SAE	HOUSING	PLUG (2 REQ'D)	"O" RING (2 REQ'D)
UNC	501105	501108	501107
METRIC	501110	501111	—

MODEL CODE BREAKDOWN



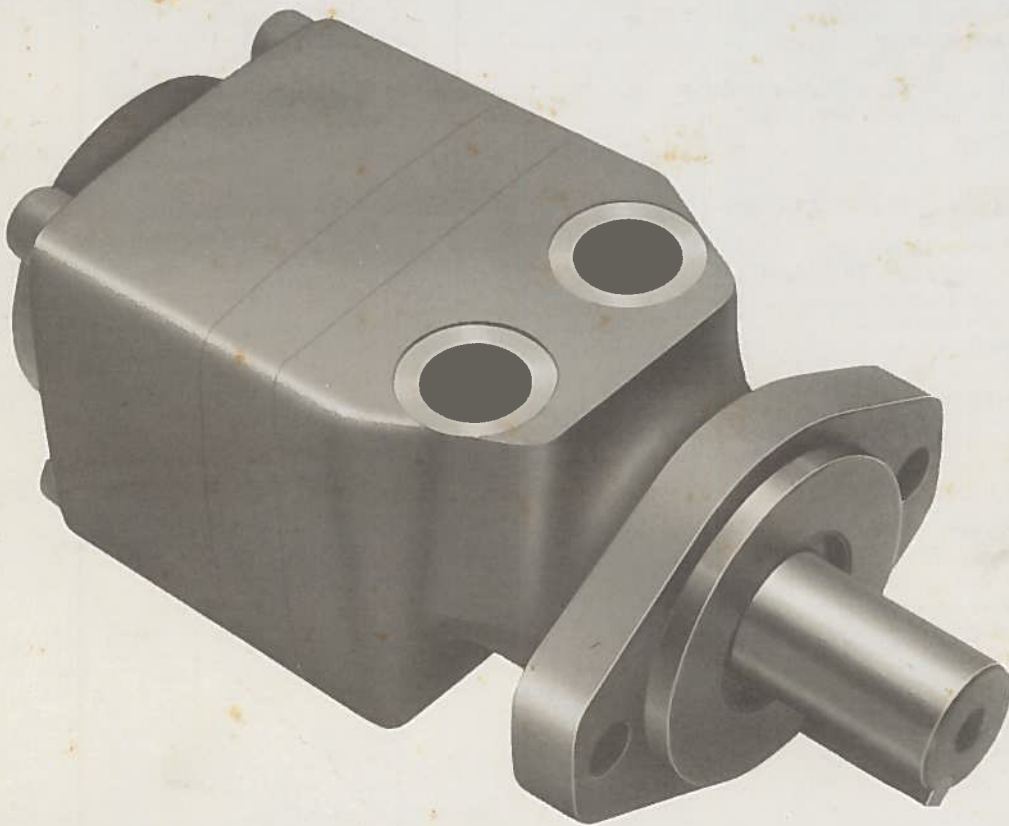
For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

Overhaul Manual

**High Torque
Low Speed
Motor**

CR-**-**(T)*(L)-30-(*)-JA



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Released 8-1-85

M-2749-S

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Section I - INTRODUCTION

A. PURPOSE

This manual describes basic operational characteristics, maintenance requirements, and overhaul information for Vickers CR series, high torque, low speed, hydraulic motors. Information contained herein pertains to the latest design series.

B. RELATED PUBLICATIONS

Installation dimensions and performance specifications are not contained in this manual. For installation and performance information, obtain installation drawing 520000 from any Vickers application engineering office or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

Section II - GENERAL DESCRIPTION

A. MODEL CODE

Variations within the CR motor series are described in the

model code breakdown. See Table 1. For torque, speed, and other application information, refer to installation drawing 520000.

MODEL CODE BREAKDOWN

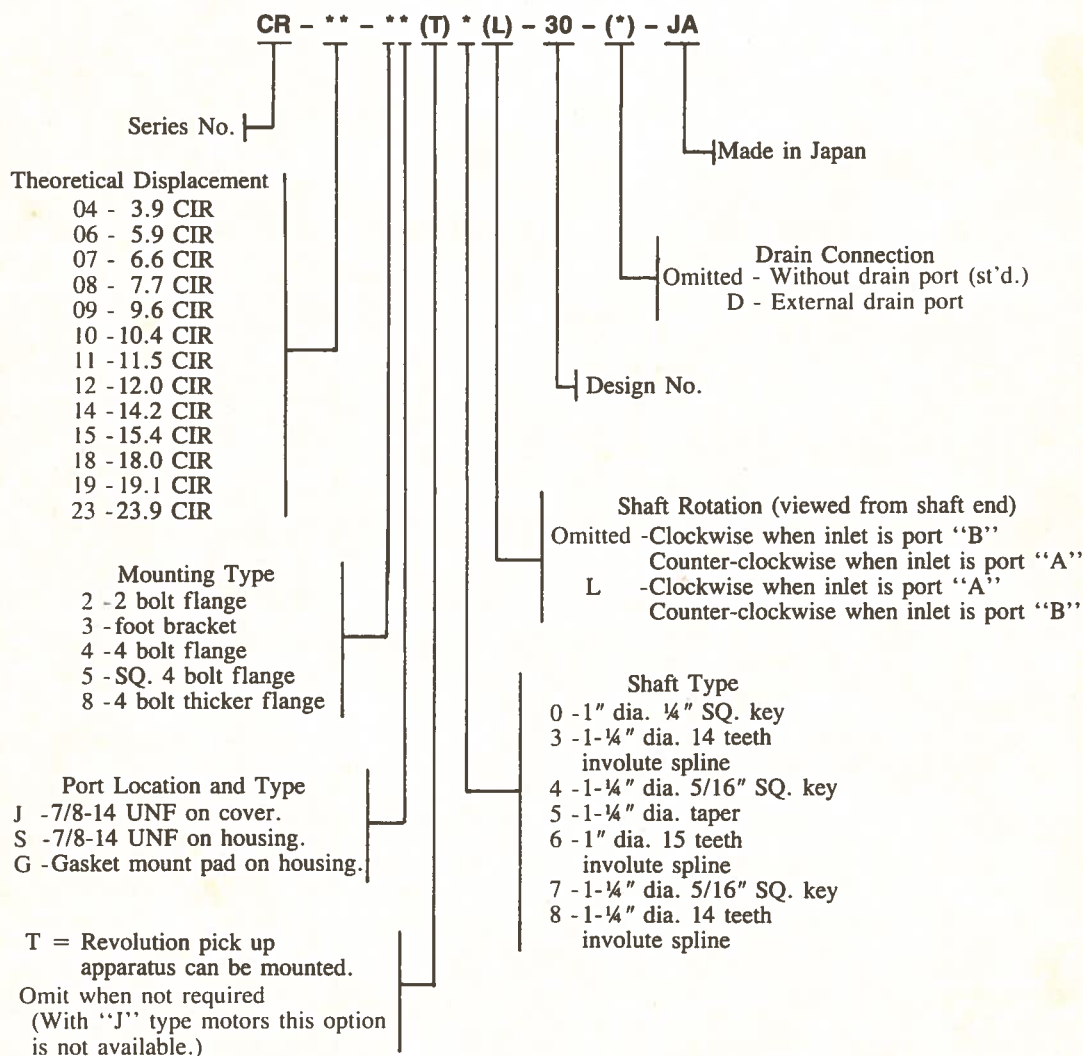


Table 1. Model Code Breakdown

B. BASIC CONSTRUCTION

Figure 1 shows the basic construction of a CR series motor. Basic components include a cover, valve block subassembly, gerotor subassembly, wear plate, universal subassembly, output drive shaft, and a housing. The valve block subassembly includes

seven internal valve spools. The gerotor subassembly includes a stator ring, seven rollers, and a rotor. Inlet and outlet port connections are located on the motor housing for standard and 'T' type models. Port connections are located on the cover for 'J' type models.

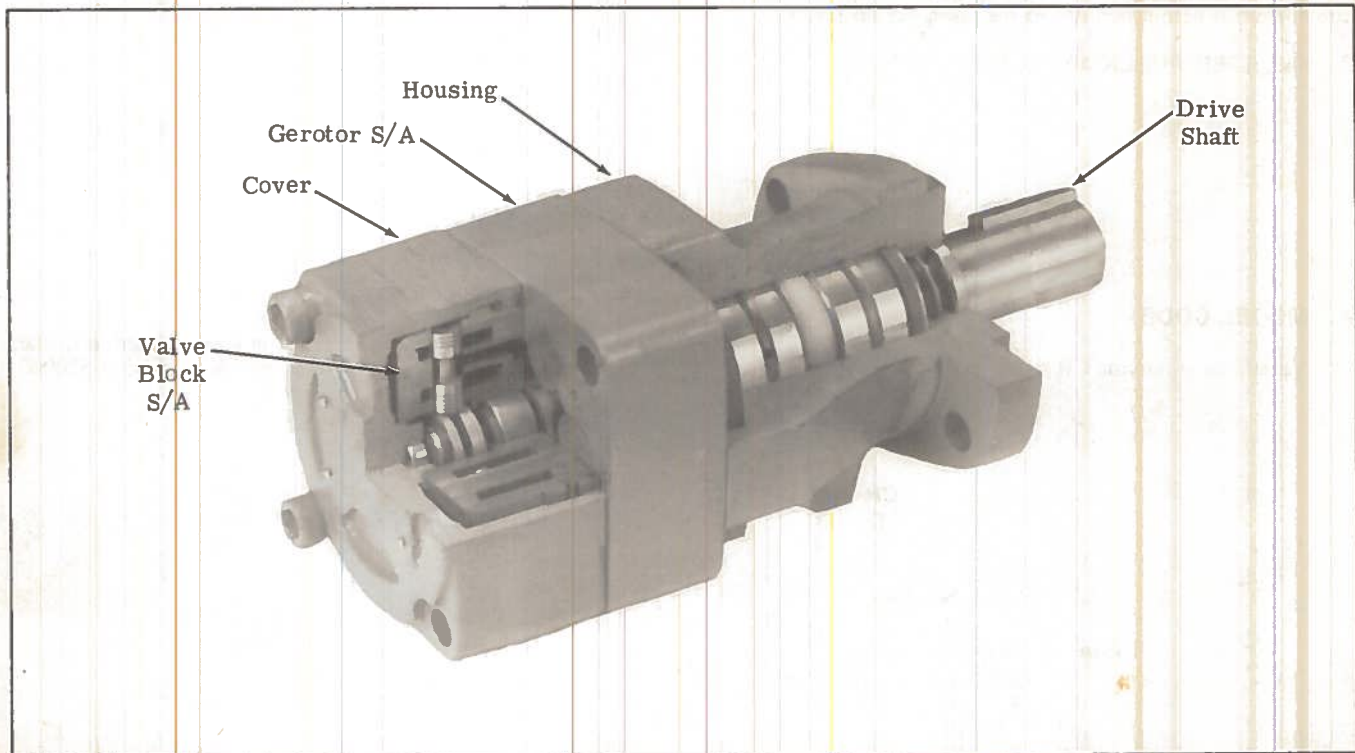


Figure 1. Cutaway View of Standard CR Series Motor

Section III – OPERATION PRINCIPLES

NOTE

Refer to Figure 2 for the following explanation on CR motor operating principles.

When the drive shaft is at zero revolution (Figure 2), pressurized fluid from the inlet port flows into the internal spool passages within the valve block S/A. At the same time, pressurized fluid enters pressure chambers 2, 3, and 4 of the gerotor S/A. Note the position of point 'A' (center of stator ring) and point 'B' (center of rotor).

When the drive shaft turns $1/14$ revolution (Figure 2a), pressurized fluid turns the rotor in a counterclockwise direction through the action (up and down motion) of the internal valve spools. This action enables pressurized fluid to enter chambers 1, 7, and 6 of the gerotor S/A. The center of the rotor (point 'B') moves to point 'B1' around point 'A' of the stator ring.

When the drive shaft turns $1/7$ revolution (Figure 2b), the center of the rotor moves from point 'B1' to point 'B2'. Pressurized fluid now enters chambers 5, 4, and 3 of the gerotor S/A. In effect, the rotor has turned $6/7$ revolution around point 'A' of the stator ring ('B' → 'B1' → 'B2').

When the drive shaft turns $1/6$ revolution, point 'B2' of the rotor returns to point 'B' (Figure 2c). Note that the rotor moved $1/6$ revolution in the reverse direction to point 'B' and the pressurized fluid within the gerotor S/A returns to chambers 2, 3, and 4 to complete one revolution. As a result, one revolution of the drive shaft receives 42 chambers (7×6) of pressurized fluid.

Thus, a CR motor produces six times the torque at a $1/6$ reduction in speed without an increase to motor displacement. By comparison, a conventional motor receives one chamber of pressurized fluid during one revolution of the drive shaft.

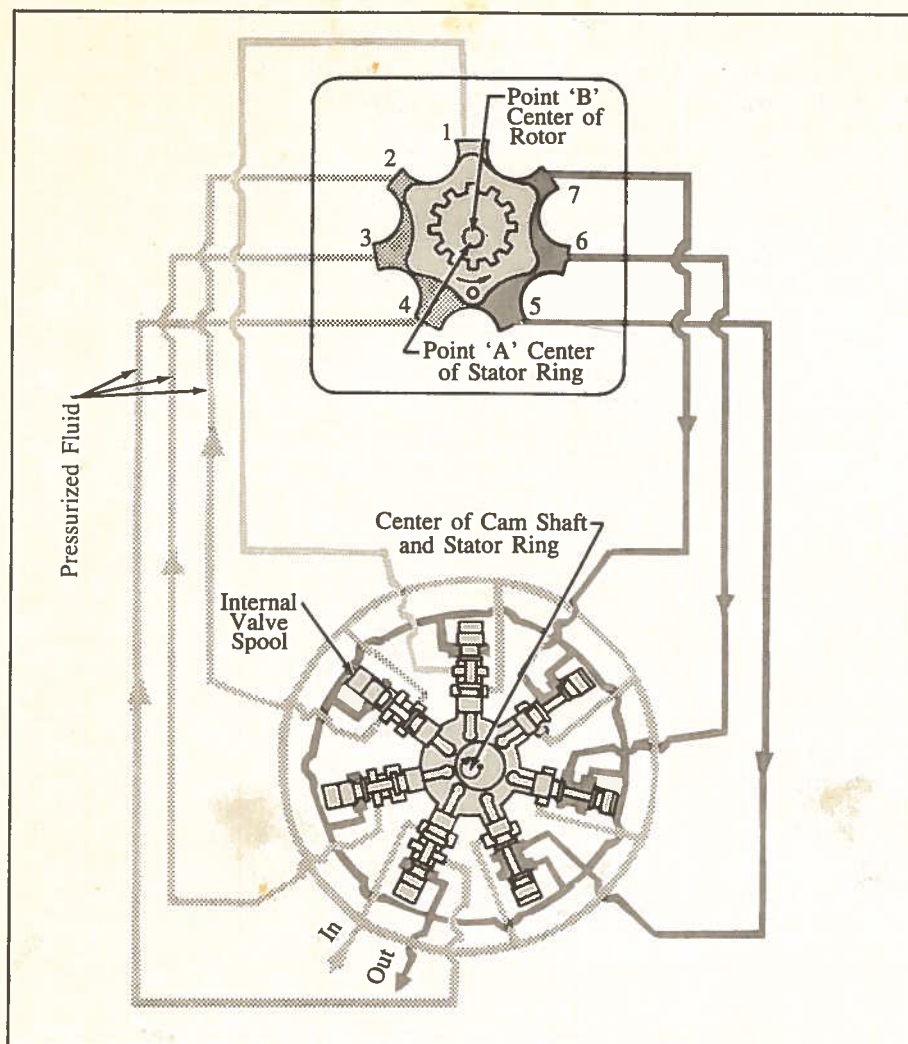


Figure 2. Drive Shaft at Zero Revolution

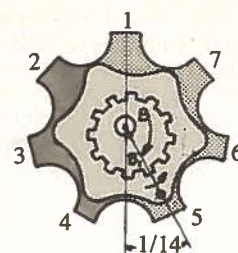


Figure 2a. Drive Shaft at 1/14 Revolution

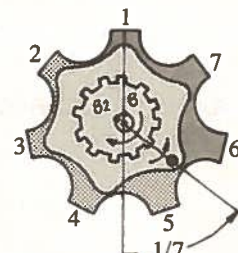


Figure 2b. Drive Shaft at 1/7 Revolution

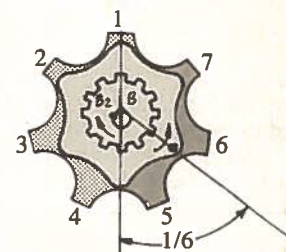


Figure 2c. Drive Shaft at 1/6 Revolution

Section IV - INSTALLATION & OPERATING INSTRUCTIONS

A. MOUNTING

CAUTION

CR series motor shafts are designed to be installed in couplings or pulleys with a slip fit. Pounding on the coupling may damage the bearings or other parts inside the motor.

1. Direct Mounting: CR motor pilot flanges are part of the actual housing. Make sure the pilot is firmly attached to the accessory pad or foot bracket in order to avoid shaft misalignment. The flatness of the mounting surface and the squareness between the shaft and mounting surface should be within .001 inch (.025mm). CR motors can be mounted in any attitude.

2. Indirect Drive Mounting: CR motors may be used for indirect drive applications. However, for applications that approach the motors maximum side load capabilities, Vickers engineering approval must be obtained.

B. SHAFT ROTATION

CR motors are capable of rotating in either direction. To reverse direction, simply reverse the flow direction as shown in Figure 3. For standard models, shaft rotation will be counter clockwise (viewed from shaft end) when fluid enters port 'A'.

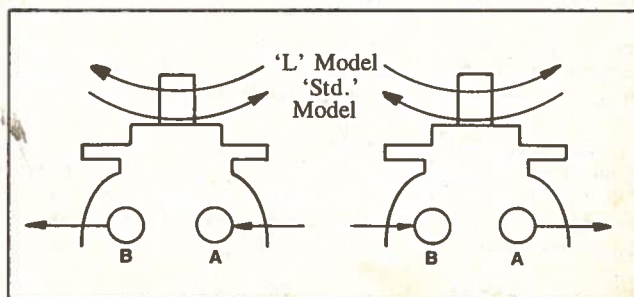


Figure 3. Motor rotation

C. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling.

NOTE

For instruction on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections that are necessary for proper installation should be used. Connecting lines (hose or tubing) should be at least the SAE port size of the unit.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of fluid flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

D. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Fluid in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of fluid assures satisfactory life and operation of system components with particular emphasis on hydraulic motors. Any fluid selected for use with motors is acceptable for use with valves or pumps.

Data sheet M-2950-S for fluid selection is available from Vickers Technical Publications, Troy, Michigan. Fluid recommendations noted in the data sheet are based on our experience in industry as a hydraulic component manufacturer. Where special considerations indicate a need to depart from the recommended fluids or operating conditions, see your Vickers representative.

CLEANLINESS

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of fluid to prevent introduction of contaminants into the system.
3. Provide continuous filtration to remove sludge and products of wear and corrosion generated during the life of the system.

Section V – SERVICE & MAINTENANCE

A. SYSTEM INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening of the reservoir, extensive damage to the pump and motor can occur resulting in noisy and/or erratic operation of the system.
2. Clean fluid is the best insurance for long service life, therefore, the reservoir should be checked periodically for dirt or other contamination.

NOTE

To insure sustained efficiency and maximum troublefree life of this precision built product, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

4. Provide continuous protection of system from entry of airborne contamination by sealing the system and/or by proper filtration of the air.

5. During usage, proper fluid filling and servicing of filter, breathers, reservoir, etc., cannot be over emphasized.

6. Thorough precaution should be taken by proper system and reservoir design, to insure that aeration of the fluid will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause excessive noises are:

1. Very high viscosities at cold or low start-up temperatures can cause pump noises due to cavitation.
2. Running with a moderately high to high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.
3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings or by fluid discharging above the fluid level in the reservoir. Air in the fluid results in a noise similar to cavitation.

E. OVERLOAD PROTECTION

Relief valves limit pressure in the system to a prescribed maximum and protect components from excessive pressure. The setting of a relief valve depends on the work requirements of the system components.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a high pressure drop. This can force particles through the filter that would ordinarily be trapped, or can cause the by-pass to open resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can damage the motor and other components. If bubbles are seen, locate the source of the air and seal the leak (see Table 2).

5. A motor which is running excessively hot or noisy is a potential failure. Should a motor become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.